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FIBG REPORT WRITING GUIDE

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One severe problem involved in publishing technical documents as been the uncertainty as to what should be reported. In some cases, project engineers are unaware of the procedures to follow. Consequently, technical efforts are not documented properly and cannot accurately be referenced or used for guidance in similar tasks. The lack of this information has resulted in redundancy, insufficient testing techniques and excessive costs for training individuals.

To alleviate this deficiency, the Structural Dynamics Branch Quality Circle Group has implemented a comprehensive training and report writing guidebook aimed at obtaining quality technical documents in a timely manner.

This report describes the six (6) stages of a technical effort. It defines the procedures of each stage and gives illustrations of processes, and sample completed forms for each.

The purpose of this report is to assist people involved in test programs documenting technical efforts in a more accurate and timely manner.

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1 INTRODUCTION

One problem involved in documenting technical efforts has been the uncertainty as to what and how the information should be reported. In some cases, project engineers are unaware of the procedures to follow. Consequently, technical efforts are frequently not documented properly and cannot accurately be referenced or used for guidance in similar tasks. The lack of this information has resulted in redundancy, insufficient testing techniques and excessive costs for training individuals. To alleviate this deficiency, the Structural Dynamics Branch Quality Circle Group has implemented a comprehensive report writing guidebook aimed at producing quality technical documents in a timely manner.

This report describes the five (5) stages of a technical effort. It defines the procedures of each stage and gives illustrations of processes, and sample completed forms for each. The text of these chapters can be read, copied and revised by users on FIBG's Vax computer (ARRAY). The purpose of this report is to provide a source of information for use by new and/or experienced personnel involved in documenting technical efforts in a more accurate and timely manner.

TEST PLAN

The sequence of technologies involved in the measurement and analysis of rapid dynamics data for system development projects can be seen in Figure 1. The process begins when an engineering problem arises which requires measurement of dynamic variations in engineering variables in order to properly define, diagnose, and solve the problem. Systems engineers investigate all aspects of the problem and prepare test plans which include the following: (1) the purpose of the test, (2) the type of transducers required to conduct the task, (3) the number and location of all points at which data will be taken, (4) a complete specification of the experimental or test conditions under which data will be recorded, (5) the length of time data will be recorded at each point and test condition, (6) necessary limitations that will be placed on the measurement instrumentation, (7) the frequency resolution and all technical parameters required to perform spectral analysis, and finally, (8) the statistical quantities to be computed and analysis methods to be employed to extract from voluminous spectral data the information required to achieve the problem definition and diagnosis objective. The completed test plan becomes the guidance document for the next step - the design of the measurement instrumentation system.

INSTRUMENTATION

Typical modern instrumentation systems are composed of three quantities and outputs: (1) a voltage proportional to the measured magnitude; (2) an indication or recording device from which one can obtain a current observation or a permanent record of the measured value; and (3) signal conditioning equipment which matches the output characteristics of the sensing device with the input characteristics of the recording device. These items are commonly

known as transducers, signal conditioners, amplifiers, switching/selective system, and record/display devices.

SPECTRAL ANALYSIS

The output of the instrumentation system, a continuous recording of the dynamic data for a specified interval of time, becomes the input to the spectral analysis system which performs the Fourier Transformations.

Statistical analyses are performed to determine both statistical characteristics of single data files and interrelations among multiple data files taken at different points or under different test conditions. Statistical characteristics include measures of average value (mean), dispersion, skewness and kurtosis. Interrelations are specified by multiple, marginal, and conditional correlations among specific combinations of data files that are of interest. When analysis methods are properly selected and the resulting output correctly interpreted, sufficient information should be at hand either to resolve the original engineering problem or to indicate a redirected effort which can pass through the entire cycle again.

CHAPTER 1

PLANNING STAGE

This chapter assists you in conducting planning meetings, obtaining approval for support efforts, and writing test plans. Brief examples of forms and procedures required to conduct these steps are included. The success of your overall project relies greatly on how well the planning stage is conducted. Much care should be given to having a complete and comprehensive planning stage.

1.1 PLANNING MEETING

The planning meeting is one or more pre-test assemblies of all involved personnel to obtain information to specify the test objectives. The objective of the planning meeting is to: (1) gather information pertinent to the problem, (2) define the scope of the test, (3) identify test facilities, (4) determine the required data reduction, and (5) assign responsibilities. The project engineer contacts all required personnel and sets the dates and locations of all meetings. Appendix D, Test Plan Outline, gives the primary task areas.

1.1.1 Information Pertinent To The Problem

In order to precisely define the objectives, several types of information need to be collected. An outline is given in Appendix D, Problem Description. This information includes a description of the test item, the operational environment, the symptoms drawing attention, the impact of the problem, and the possible causes. These factors will be discussed in detail in the following sections.

1.1.1.1 The Test Item -

Describing the test item can involve a variety of factors such as dimensions, weight, shape, color, and material composition. Photographs, drawings, and video recordings are most useful in describing the test item. For professional photographs advance arrangements can be made with tech photo (4950th Test Wing/RMPI, 54085). Inspection of the test item is recommended.

1.1.1.2 The Operational Environment -

The purpose of the operational environment is to create or assimilate the characteristics the vehicle, equipment, structure, etc. will encounter in normal operation. It should be determined if the test is to be conducted on an aircraft or in a test facility such as a wind tunnel, laboratory, or acoustic chamber. Laboratory shaker tests include fatigue testing of coupon specimens, ground vibration testing of full scale aircraft, and vibration testing of equipment items. Thermal factors include operational and storage temperature ranges. Such operational environmental factors as sound pressure levels and

frequency range should also be considered. For example, FIBG's facility has the capabilities for acoustic testing described in Table 1 of reference 1.

1.1.1.3 The Symptoms Drawing Attention -

When planning a test, certain symptoms are to be explored. These symptoms should include a detailed description of physical damage on a test item as well as potential harm or injury to a nearby person during operation of an Air Force system. Examples of physical damage can be cracks in structures, broken bolts, and equipment failures. Some causes of symptoms could eventually lead to such catastrophic failures such as loss of an aircraft or life of a human being.

1.1.1.4 The Impact Of The Problem -

The impact may be either a loss of system functions or a drop in efficiency of system performance. These in turn lead to increased costs due to down time for maintenance and repair. Personnel performance and safety may also be affected.

1.1.1.5 The Cause Of The Problem -

A block diagram can be used to outline and clarify the test setup. Potential failures can result from environmental or operational factors. Temperatures, pressures, accelerations, and acoustics levels are some of the environmental factors to consider. Operational factors to consider for an aircraft are altitude, speed, maneuver type, store configurations, and gross weight. The causes can be identified in various ways such as studying time

histories or frequency spectrum of critical parameters. Simulation in wind tunnels, with shakers or by acoustical excitation may help to identify the cause of the problem.

1.1.2 Objectives Of The Test

For any technical problem, the first and most important requirement is to obtain a clear and concise definition of the objectives of the task and why the effort needs to be conducted. The objective of this technical effort should include the situation that gave rise to the problem and what we hope to achieve as a result of this effort. Several iterations are usually required before a final statement of the test objectives are defined. A flow chart showing the steps for conducting in-house tests is shown in Figure 2.

1.1.3 Scope Of The Test

The scope of the test defines the boundaries of the test(s) which in turns determines the number and type of transducers that will be used as well as the range of test conditions needed to meet the requirements of both the customer and the Laboratory.

1.1.3.1 Customer Requirements And Laboratory Purposes -

The primary objectives originate in the situation that gave rise to the problem and defines what achievement is expected as a result of the test program. Secondary objectives may arise from the dynamics research mission of the Flight Dynamics Laboratory. A plan of attack must be chosen to integrate

these two purposes in the actual conduct of the test program.

1.1.3.2 Variables Of The Test -

Variables that influence a test output include both test item characteristics and the test condition specification. Test conditions include both wind tunnel and flight test variables. Examples of test conditions are velocity, altitude, latitude, attitude, temperature, pressure, weight, etc.

1.1.3.3 How Many Conditions -

Test conditions cover an array of variables. During a flight test, altitude, airspeed, Mach number and attitude may be varied. The number of test conditions and time for each have an impact on the method of recording and analyzing the acquired data. For low frequency measurements, longer records are required. Measurements for each condition may be recorded on different tracks of a tape recorder or directly entered to analysis equipment such as a spectrum analyzer. A large number of test conditions can greatly affect the data acquisition and data analysis tasks. If an instrumented flight involves 10 airspeeds, 10 altitudes and 10 gross weights, a total of 10 x 10 x 10 = 1000 different test conditions are needed to cover all of these variations.

1.1.4 Facilities And Equipment

During test design, the facilities required should be determined. Facilities available at the Structural Dynamics Branch include:

1. Acoustic Chambers

   Wideband noise test chamber

   Small acoustic chamber

   Aeroacoustical facility

2. Vibration testing areas

3. Mobile facilities

   Mobile data acquisition van

   Mobile experimental laboratory (MEL)

4. Calibration laboratory

5. Analysis laboratory

Using the information acquired during pretest and planning meetings, an instrumentation team should design an optimum system for completion of the test objectives.

A large amount of supporting equipment is available for use on a test. About 5000 accountable equipment items, including oscilloscopes, voltmeters, tape recorders, shakers, calibrators and many others, are available. Support electronics designed in-house include amplifiers, filters, transducers and modal data acquisition systems.

1.1.5 Data Reduction

Data reduction requirements for the test must be well defined in advance. Certain questions must be answered. Whether the test will be acoustic or vibration determines how the plots will be formatted. Will correlation be or any other special software be required? Types of data reduction that are available are described in Chapter 3.

1.1.5.1 Channels -

A channel is the track number in which data is recorded. The test plan should indicate which channels are of most importance, and in what detail must each channel be analyzed. It should also state how the data should be displayed or plotted? For instance, should 8 curves or lines be placed on one graph or should there be 8 separate graphs; Should the data be displayed in tabular form?

1.1.5.2 Frequency Range -

The frequency range of the data is required to determine the bandwidth selection of the data acquisition system. The bandwidth of a signal is the difference between the maximum and minimum frequencies of interest. Bandwidth is also used to define the size of frequency resolution (delta f) in spectral analysis.

1.1.5.3 Graphs -

Data output is usually presented in the form of graphs. These graphs can be presented in log-log, log-linear, linear-linear or linear-log scales for the x and y axes. The functions plotted could be Auto Spectral Density (ASD), Sound Pressure Levels (SPL), Probability Density Functions (PDF), time histories, and many others.

1.1.5.4 Mathematical Models -

If the values of the range (the set of values the function or transformation may take on) and domain (the set of values which the independent variable may take on) of a mathematical function give the best fit to some measured data, the function then models the data. Clearly some functions will be better models than others. Data collected later can then be compared to and plotted with data generated by previous mathematical models. For example, the theoretical impulse response of a mechanical system might be plotted on the same graph as the actual measured response.

1.1.6 Responsibilities

At the planning meeting, responsibilities of all organizations and personnel should be identified. Lateral and vertical communication are important to ensure smooth flow of project information. Common forms of communication include meetings, phone calls, computer mail and memos. He/she is also responsible for documenting the test program and interpreting the results.

1.1.6.1 Project Engineer -

The key person for all projects is the project engineer who is responsible for developing the hypothesis, planning the test(s) to confirm the hypothesis, conceives possible solutions or fixes, and plans the testing of the fixes. The project engineer is responsible for the entire test program. He/she coordinates all matters associated with the program such as finances, personnel, and all changes in program status. The project engineer writes the test plan. All changes or variations should be cleared through this individual or their appointed assistant. The project engineer also keeps a current folder on all transaction and activities pertaining to the project.

1.1.6.2 Instrumentation Engineer -

The instrumentation engineer, who conducts the test and acquires the data, is responsible for instrumentation, data acquisition, test procedure documentation, and test management. He oversees cable fabrications and bracket designs. He monitors the test to ensure all data are recorded on tape or paper. He keeps track of operational and non-operational transducers. The evaluation of data quality on site is the responsibility of the instrumentation and project engineers. The instrumentation engineer directs the test technicians in preparing for and conducting the tests and works closely with the project engineer in writing the instrumentation section of the final report.

1.1.6.3 Analysis Engineer -

The analysis engineer is responsible for transforming, plotting, and modeling test data. Transforming as it is used here is the changing of an equation or algebraic expression by substituting for the variables their values in terms of another set of variables. He directs the analysis technician as to which data records are to be digitized for further analysis. Required plots and checks for accuracy are defined by the analysis engineer, who is also responsible for the analysis section of the final report.

1.1.6.4 Technicians -

The test technicians provide technical support in fabricating electronic and mechanical components for the test. Specialized technicians work in the calibration laboratory and the analysis laboratory. One analysis technician edits data tapes received from tests and plots analog or digitized data as directed by the analysis engineer. A second analysis technician ensures that the data reduction and analysis equipment are operating properly. Other technicians are assigned to specific projects and work under the direction of the test and project engineers.

1.1.6.5 Travel -

Travel requirements should include test planning trips, as well as the actual test conducting trips. Travel estimates depend on the mode of transportation, per diem, number of travelers, rental vehicle and miscellaneous costs. These costs should all be included in the test cost estimate. Each

person is responsible for his travel arrangements; however, all travel arrangements should be coordinated through the project engineer. When using FIBG mobile data acquisition vans, special factors need to be considered in preparing the van for travel.

1.1.6.6 Cost -

For each R and D program a cost estimate should be made. The detail of the cost estimate depends on whether the program is in-house, support to others or contract. The estimate includes manhours, required personnel, travel cost, equipment cost, supply cost and other cost. A sample estimate is included as Figure 3. Note that for manhour cost the formula is the estimated hours times the annual salary divided by 2087 and then multiplied by an overhead factor of 1.29.

1.2 OBTAINING APPROVAL FOR SUPPORT EFFORT

If the effort requires more than 40 manhours, an official letter requesting support should be sent to the Flight Dynamics Laboratory.

1.2.1 Request For Technical Support

Technical assistance by the Flight Dynamics Laboratory is obtained by an official letter of request to the Director (AFWAL/FI) from the desiring customer. A description of the problem as complete as possible, giving the current state of the evidence should be included as an attachment to this letter. Personnel in the affected system office may be in a better position to

describe the problem and all its ramifications than are the Flight Dynamics Laboratory engineers temporarily assigned to accomplish the project. Accordingly, this problem description will normally serve as the first section of the final technical documentation of the experimental dynamics investigation, and its author may be included as a co-author of the full report. As an aid in organizing this information, a suggested format for the problem description is given in Appendix D. This format also serves as a check-off list for the types of information to be included. Of course, not all of these items will be applicable to every project.

The problem description is used by Flight Dynamics Laboratory engineers to prepare a Test Plan for carrying out the measurements and data analysis required for each of the joint system projects. This test plan is the technical part of the documentation that must be approved by both the requesting office and the Flight Dynamics Laboratory before any work can be undertaken. The test plan format is also given in Appendix D. System personnel who are cognizant about any of the topics included may wish to provide guidance to the engineers preparing the test plan. Such guidance may range from informal telephone comments to the actual drafting of parts of the test plan. The optimum number of measurements and degree of analysis are not always physically possible or economically feasible. Consequently, free communication on these matters is necessary to achieve the best design of the test plan. The approved test plan will normally follow the problem description as the second section of the final technical documentation of the joint system experimental effort.

1.2.2 Response Letter To Support Request

After evaluating the request letter, FIBG will respond with a letter stating whether or not the support can be provided. This response will be written for FIB Signature and a copy will be provided to AFWAL/GLXRF (A. HARRIS). The response letter should include the approved test plan and an estimated cost of the test. The cost estimate will include manhours, travel, supplies, and equipment estimates as described above. Preparation of this letter may be preceded by telephone communication and a planning meeting with the customer to determine the scope of the test. A preliminary test schedule showing the planned time frame for test should also be prepared at this time.

1.2.3 REQUESTING A JOB ORDER NUMBER (CUSTOR AFWAL FORM 143)

After obtaining approval to perform the support effort, a CUSTOR AFWAL Form 143 requesting a system support Job Order Number(JON) should be completed and forwarded to AFWAL/GLX. After receipt of the JON, work and charges on the support can begin.

1.3 TEST PLAN

The test plan is usually written by the project engineer with input from the instrumentation and analysis engineers, technicians, supervisors, customers and other personnel. A sample test plan is included as Appendix E.

1.3.1 Cover Sheet

A cover sheet should have an Organizational Block, Title of Test, Name of Author, and Test Plan Date. These items are necessary to readily identify the test name and project engineer. A sample test plan cover sheet is included as Appendix E.

1.3.2 Follow Outline In AFWAL-TR-80-3080

In writing the test plan, the outline from AFWAL-TR-80-3080(reference 2) given in Appendix D should be followed. This outline should serve as a guide to ensure that all pertinent information is included in the test plan. As shown in the outline the major headings should be: 1)PROBLEM DESCRIPTION, 2)PROGRAM OBJECTIVE, 3)DATA REQUIREMENTS, 4)DEVELOPMENT OF TEST PLANS and 5)DOCUMENTATION OF RESULTS.

CHAPTER 2

ACQUISITION STAGE

2.1 RECORD KEEPING

Keeping accurate logs and records (bookkeeping) in the field is important in ensuring data quality and rapid preparation of a final reporting document. Papers, records and forms in the field should be dated to ensure accurate reconstruction and description of the events that occurred.

2.1.1 Transducers

A description of some transducers used in data acquisition can be found in Reference 1. Specifications of several transducers owned by FIBG are included as APPENDIX F. A sample description of a transducer for incorporation in a technical report is as follows:

The sensor used was a model manufactured by company.

for example:

The accelerometer used was a model 902H manufactured by Columbia Research Labs..

or

The pressure transducer used was a model LQL-125-5D manufactured by Kulite.

2.1.1.1 Type -

Transducers and sensors are used to measure pressure, sound pressure level, strain, temperature, acceleration, airspeed, and displacement. Transducers include both active signal generating and passive signal conditioning types. These transducers can be a strain gage, piezoelectric, piezoresistive, condenser microphone, thermocouple and others. The transducer may be optimized for different frequency ranges and temperatures.

2.1.1.2 Location -

Locations of transducers on a test item must be well specified. The locations are highly dependent on the problem that is being solved. On a vibration test, for example, one must ensure that no accelerometers are located on a vibration node. On an aircraft, transducers should be specified by the fuselage station, water line and buttline. A sketch of the test item with transducer locations is helpful. The locations of transducers are usually determined by a consensus of critical location, as determined by project engineers, working engineers and technicians. A project engineer may desire more transducers than the capability of the measurement system.

2.1.1.3 Direction -

Transducer orientation should be defined. Usually accelerometers are oriented to sense vertical, lateral and longitudinal accelerations. Sometimes the accelerometer may be oriented to sense acceleration in a direction parallel to a component axis.

2.1.2 Equipment

Selecting equipment to use on a test include a variety of factors. Some factors are test type, test location and power availability. A laboratory or field test might require transducers, signal conditioning, power supplies, data recording, equipment, noise sources, and vibration sources. In addition a mobile data acquisition facility might be required. On site plotting capability using digital plotters may also be required.

2.1.2.1 Signal Conditioning And Recording -

Specifications of some FIBG signal conditioning equipment are also in Appendix F. Signal conditioners include automatic gain ranging amplifiers (AGRA), Datel amps, filters and other special purpose electronics required to optimally link a transducer to a recorder. Recorders include the Leach, Honeywell 101,.Honeywell 96, Ampex, Kyowa and Digital Memory.

2.1.2.2 Block Diagram Of Test Set-up -

Every test plan and test report should include a block diagram of the data acquisition system used for the tests. This should include blocks for transducers, signal conditioning, data recording, and data recovery. A block diagram shows at a glance a good overview of the equipment used on the test. A block diagram for a typical FM recording system is shown in Figure 4. Also, a drawing showing transducer layout on a recent test is shown in Figure 5.

2.1.3 Test Conditions

To be well documented, a detailed list of records made during the data acquisition should include the date and the following data.

2.1.3.1 Environmental Data -

A log of environmental measurements such as temperature and barometric pressures should be keep while at the test site.

2.1.3.2 Test Item Data -

Any changes in the test item during the testing process should be noted. Test item data that may change include weight and size.

2.1.3.3 Operational Data (Test Conditions) -

Test condition changes must be tabulated or listed. For a wind tunnel test, some operational changes include Mach number, altitude, and model angle of attack for each record. Operational data specified by the project engineer in the test plan is to be tabulated for each record of collected data.

2.1.3.4 Amplifier Gains -

For each amplifier in the signal conditioning, a record of gains must be documented in order to determine sensitivities for conversion to engineering units. AGRA amplifiers have gain codes bits which may be recorded on magnetic tape to recover the proper sensitivity on playback. Fixed gain amplifiers must have their gains logged manually for use by playback personnel at a later date. Sometimes amplifier gains are adjusted to provide normalized sensitivities, such as 1g/volt for an accelerometer channel.

2.1.4 Document All Changes In Test Plan

Deviations from the test plan must be annotated in a project notebook, data acquisition log or computer file. Scraps of paper are often lost or destroyed. Forms can be most helpful to keep track of test setup and test conditions as they are conducted. A sample form is shown in Figure 6. Forms should also be used for each data record (analog tape, digital tape, disk, etc. which describes the test setup, transducer identification and other pertinent information).

2.1.5 Photographs

Photographs can be taken of the test item, test-set up and sensors. These pictures can be useful in determining transducer location, orientation and position during the analysis and report writing phases. Newer techniques include video cameras for test documentation. Computer displays and animation are also sources of photographs and figures required in a test report. A photograph of the item being tested during the actual test condition can be helpful. For example, on taxi testing, a photo or video of an aircraft travelling over a runway provides documentation. Also, data analysis can be accomplished using some of the state of the art video analysis techniques. The test condition description, time and date can be superimposed on a video image if desired to help document the test. Calibration of transducers electronic systems can also be documented by photos and video.

2.1.6 Calibration

A number of calibration techniques are currently used for a large number of tests. The type of calibration is dependent on the test type and transducers selected as well as both the amplitudes and frequencies of the measurands. Calibrations can be done in the laboratory on individual transducers or entire systems, before the test. Zero signal level records should be made to check noise floor. End to end calibrations before and after the tests should be conducted at the test location. Automatic calibrations before and after the occurrence of each test condition are also possible. Accuracy of the calibration should also be estimated based on thermal, pressure

and operational environments of the transducers.

2.1.7 Test Procedure

The test procedure should be well documented in the field. An accurate outline of the test procedure should be included in the test plan. The actual series of steps performed during the test should be documented. An estimate of the accumulated error should be stated.

2.2 REPORT READY PLOTS ON-SITES

Modern test equipment and instrumentation allows production of report ready plots at the test site. For example, a spectral plot can be generated away from the test cite by using the Mobile Experimental Laboratory (MEL). Now capabilities exist to get spectral plots on site within a manner of minutes. This allows fast conversion of sensor data to engineering units and enhances the decision making capability in the field.

Using modern data acquisition and analysis systems, time histories ready for inclusion in a technical report can be generated in the field. A sample time history generated using the Wavetek Spectrum Analyzer is included as Figure 7.

Computer aided calibration can present report ready documentation of transducer calibration (pre and post calibration) for possible inclusion in a report. This can include amplitude sensitivity information and transfer function plots for frequency critical application.

2.3 REPORT READY TABLES ON-SITE

Usually tables and test logs on site are handwritten. New techniques could include typing data on site into a portable computer, for immediate print out, in letter quality. This eliminates the need to decipher handwritten notes and eliminates a step in reaching a goal of a report ready table on site. An example of a computer generated table is shown in Table 2.

CHAPTER 3

REDUCTION STAGE

The Structural Dynamics Branch recovers, edits, transforms, and presents both analog and digital data. These capabilities are required to accurately describe the operating environment of flight vehicles and to access the accuracy of analytical prediction methods. The process of transforming the dynamics data from the raw form to that which yield the information required by engineers and scientist consists of five major tasks: data recovery, editing, analog to digital conversion (if required), single channel transformations, dual channel transformations, and graphic presentation.

3.1 TYPES OF DATA RECOVERY

The data are usually recorded on tape, floppy disks, or hard disk. The first phase of data reduction is verification of the dynamics data and selection of usable data for further analysis.

3.1.1 Analog Data

The analog (continuous) data are recorded on instrumentation tape along

with amplifier gain, time code and voice information. This type of data can be recorded using frequency modulation (FM), amplitude modulation (AM), or phase modulation (PM). Time division multiplexing (TDM) and frequency division multiplexing (FDM) may be used to place data from several transducers onto one tape recorder track.

3.1.1.1 Frequency Modulation (FM) -

Frequency modulation(FM) records data from zero frequency (DC) to a maximum frequency determined by the tape speed. The signal is frequency modulated with an Inter Range Instrumentation Group (IRIG) compatible subcarrier center frequency between 200 Hz and 1.999 MHz. The frequency can deviate between 20 Hz and 800 KHz within a deviation percentage range of 4% to 40%.

3.1.1.2 Amplitude Modulation (AM) -

Direct recording of signals (x(t)) use amplitude modulation techniques. Amplitude modulation causes the amplitude of the encoded carrier wave to vary with the input signal amplitude. For AM encoding, the carrier frequency is constant. The signal is encoded into the carrier amplitude by the relation defined on page 2-85 of Reference 2. If the signal amplitude exceeds the carrier amplitude, a condition known as over-modulation occurs. The limited dynamic range obtainable by AM encoding is the result of interference from additive noise or by gain variations. Since dynamic range of this recording technique is limited to 20 to 40 dB, the use of AM encoding for acoustic and

vibration signals is generally avoided.

3.1.1.3 Phase Modulation (PM) -

Phase modulation is similar to FM encoding in that both have constant carrier amplitude and encode the signal ($x(t)$) in the total phase $x(t)$ of the carrier. In PM encoding, the signal controls the instantaneous phase excursion of the carrier. The maximum phase excursion in PM is independent of signal frequency, while the maximum frequency excursion is proportional to the signal frequency. PM systems are better suited for encoding of high frequency signals than are FM systems. They are used mainly in high speed digital recording. Modems operating at 1200 bits per second use phase encoding.

3.1.1.4 Time Division Multiplexing (TDM) -

In time division multiplexing, each input channel is sampled for a fixed time (dwell time) before the next is selected. The first channel is not sampled again until after the last channel's dwell time. A frame is defined as an interval of data samples that includes at least one sample of each channel. The number of frames per second is the effective sampling rate. Time Division Multiplexing is illustrated Figure 8 from reference 3.

3.1.1.5 Frequency Division Multiplexing (FDM) -

In frequency division multiplexing, each channel of data is assigned a given frequency band as shown in Figure 9 from reference 3. Frequency multiplexing is the process of adding (mixing) signals with different carrier frequencies. The input channels can then be demultiplexed by band pass filtering and FM demodulation. The important characteristics of frequency multiplexed systems are the bandwidths around each carrier and the carrier frequency separations. The dynamic range increases with increasing bandwidth, but decreases due to channel cross-talk if the carriers are not adequately separated. Since the total bandwidth available is generally fixed, there is a tradeoff between dynamic range and the number of channels that may be accommodated.

3.1.2 Digital Data

In contrast to continuous wave modulation, where the carrier wave is a sinusoid, pulse modulation encoders use a pulse train as the carrier wave. As in the case of the time division multiplexers, pulse modulators sample the signal at certain times (usually at constant intervals) so the signal must not contain frequencies greater than half the sampling rate. The sampling rate of a single channel modulator is the pulse repetition frequency. Pulse modulation may be easily combined with multiplexing to produce a pulse train representing frames of samples from each input channel.

3.1.2.1 Pulse Amplitude Modulation (PAM) -

Pulse Amplitude Modulation is the pulse analog of AM encoding. The amplitude of a pulse train varies with the signal voltage. On most FIBG tests, transducer signals (data channels) are recorded using FM, one channel per track. The gain codes of each Automatic Gain Changing (AGC) amplifier are recorded on a separate track using Pulse Amplitude Modulation (PAM) techniques. Figure 4 showed a typical system for recording twelve accelerometer signals. Typically, amplifier gains are recorded on track number 13. Inter Range Instrumentation Group-B (Irig-B) analog time code is recorded on track 14 and voice on the edge tracks.

3.1.2.2 Pulse Time Modulation (PTM) -

Pulse time modulation is the pulse analog of FM encoding. The pulse amplitude remains constant, and the signal's value at the sample time is encoded into time parameters of the pulse. In pulse frequency modulation, the frequency of pulse repetition is varied around the center frequency just as in FM encoding.

3.1.2.3 Pulse Width Modulation (PWM) -

Pulse width modulation is also known as a pulse duration modulation, the pulse width corresponds to the signal amplitude.

3.1.2.4 Pulse Position Modulation (PPM) -

Pulse position modulation results in pulses of uniform width, but with the spacing between pulses varied to encode the signal.

3.1.2.5 Pulse Code Modulation (PCM) -

In a pulse code modulation system each sample value of a signal f(t) is converted to a code formed by a pattern of digital pulses representing binary numbers. Each voltage level is then represented by a certain pattern of pulses. Thus instead of transmitting the individual samples, the corresponding pulse pattern is transmitted. PCM encoding is shown in Figure 10 from reference 3.

3.1.3 Root Mean Square (RMS)

After the data are digitized, the dynamic data are often plotted as the RMS time history. This provides a quick-look tool to determine the statistical properties of the signal such as self stationarity and randomness. RMS Time History data also help to determine if gain changes have occurred.

3.1.4 Select Data Display

To select the best way to display data, the objective should be clearly understood. For example, if interested in acoustic fatigue, you may want to display your data as narrowband frequency spectra of sound pressure levels or one-third octave plots. If you are interested in amplitude peaks, the data may

best be displayed by amplitude versus time or spectral analysis using a linear scale on the y axis. Acoustic fatigue on Trans Atmospheric Vehicles (TAV) may require a series of acoustic spectra as a function of temperature. Combined environmental factors such as temperature, ambient pressure, moisture, and solar radiation are becoming more important as new aerospace vehicles are designed to operate near earth and in space.

3.2 TYPES OF EDITING

The first step after acquiring data in the field is editing. This involves setting editing criteria for elimination of bad data, such as clipping or loss of signal. In addition, the project engineer must decide what data is of value for further analysis. The data records on the tape are compared with the voice track for test conditions identification and the time code for time code for time correlation purposes.

3.2.1 Visual Inspection

Visual Inspection of data measurements is accomplished by several means as discussed in the following paragraphs.

3.2.1.1 Oscilloscope -

The recorded signal is played and observed on an oscilloscope to inspect voltage levels and to determine the signal quality based on past experience. Some of the things to look for are low level, clipped and noisy signals, data out, bad gain codes, loss of frequency carrier, bad data record identification and other inconsistencies.

3.2.1.2 Strip Chart Recorder -

Since the oscilloscope provides no permanent record of the data, it is often necessary to plot time histories of the data on oscillograph paper. This is another quick look means of determining data integrity for high frequency data. In addition to the signal trace, the time code can be displayed on the oscillograph so that specific sections of data can be identified by time for analysis. For some data, preliminary amplitude values may be derived from the oscillograph trace. Newer techniques involve use of digital plots directly from a spectrum analyzer.

3.2.1.3 PCM Playback -

For serial PCM data, it is difficult to ascertain data quality while looking at the serial bit stream. It is necessary to have a PCM decommutation system to decode and demultiplex the assorted signals that are embedded in the bit stream. Some PCM playback systems currently in use are the EMR 708, Base 10 decoder, the MASSCOMP computer in the Mobile Experimentation Laboratory Van, and a universal telemetry system.

PCM playback is accomplished in the laboratory and the field. PCM data that is recorded on one track of magnetic tape are played back through the EMR 708 PCM decom system in the analysis phase. The EMR 708 converts serial PCM data to parallel digital data. Using a computer interface and software, the parallel data are transferred to an IBM compatible computer tape for use with the VAX 11/780. For each test using PCM, the instrumentation engineer, analysis engineer or technician program the appropriate PCM decom parameters to account for things such as bit rate, subframe identification and calibration constants for each channel. The calibration equation is of the form $y = mx + b$, where m is the channel sensitivity in engineering units per count, b is the offset, and x is the number of digital counts.

In the field, a quick look of PCM data can be obtained by using the Base 10 PCM decoder. This allows the user to get a quick look of any single channel in the serial bit stream. For example, if an individual wants to look at the signal from an accelerometer called A1, he can select this channel and the decoder will display the number of counts being outputted from that transducer. In addition, a Digital to Analog (D/A) converter allows the engineer to view the data on an analog scope. For detailed editing of the data in the field, the larger EMR 708 system is used. This system displays the counts and engineering units for all channels simultaneously on a CRT display. In addition, up to 16 D/A outputs can be used for displaying the data on oscilloscopes or oscillographs.

3.2.1.4 Voltmeter -

A voltmeter is used to check voltage levels of signals. In the field and in the laboratory a voltmeter measures RMS, DC, and AC voltages. A multi-meter measures voltage, current and resistance.

3.2.1.5 Spectrum Analyzer -

Data are viewed in the frequency domain with a spectrum analyzer to help decide whether to examine or delete a particular band of frequencies. A quick look at the data can be made using a spectrum analyzer and plotting the output on an X-Y plotter. The data signal may be filtered with low, high, or band pass analog or digital filters. The results of this phase of data verification are used to determine the frequencies of interest for further analysis. The results are also used to look for the occurrences of undesirable signals induced by electrical noise such as 60 hertz house power frequency or 400 hertz aircraft power frequency. In vibration, it is difficult to distinguish a 60 hertz mode from 60 Hertz noise. Also on some tests the mechanical phenomenon of interest may induce known frequencies. For example, on vibration testing of helicopters the frequencies induced by blade passage should be observable in the frequency spectra. If they are not present the data may be of questionable quality. Gunfire is another example of data that should have harmonic content. The spectrum should be repeatable for different data records for the same test conditions and transducer.

3.2.1.6 Computer Printout And Plots -

Tabular printouts can be useful in editing data. These consist of computer generated tables expressing the data in engineering units. Tables give more precise values than strip charts. For example, to see precise PSD values for each frequency of a plot or segment of data, a table can be generated listing all of these frequencies and values. They may also be used to select maximum and minimum values for your report ready graphs or plots.

In addition to plots from spectrum analyzers and oscillographs, a variety of plots can be generated from digitized data. The plots are used to check data quality and to edit data. Examples include Probability Density Function (PDF, also known as Amplitude Probability Density, (APD), Cumulative Distribution Function (CDF), Time Histories, Auto Correlation Function, Cross Correlation Function, Power Spectral Density, (PSD, also known as Auto Spectral Density and Spectral Density), Joint Power Spectral Density, and cross channel plots of two parameters. Usually a large number of these graphs are plotted and a judgement is made as to which plots are incorporated into a report. A file of these plots is usually kept until the report is published. This can be helpful when reviewing the report; and used for future reference.

3.2.2 Determine Data Quality

Data can be classified as good, bad, marginal, desirable, undesirable, and missing. Good data represents the predetermined or expected results and falls in the expected range for a given condition. Good data do not contain noise, spikes, 60 or 400 hertz, or other undesirable contamination. The bad data

signal may be clipped, lost or missing due to power failures, have erroneous gain code reading, have incorrect sensitivities applied or have similar undesired corruption. Marginal data are seemingly bad data that can be manipulated into a usable form. For example, a low signal level embedded in noise may be recoverable by statistical filtering techniques. Sometimes for multichannel systems, marginal data exist when some of the channels are good but not all. An example would be a 12 channel system, where 10 channels are good and 2 are bad for a given test condition. Undesirable data is information that the project engineer does not need to work the problem. Undesirable data may be good or bad data and should be filed away for future reference. Desirable data is acceptable data that the project engineer needs to solve the initial problem; and will probably incorporate in the final report. It usually takes several iterations to reach this point.

3.2.3 Video Recording

New techniques in vibration and acoustics testing use video recording as a documentation and measurement tool. They provide ways to edit test data. For example, video recordings of test conditions may be used in conjunction with data recordings to insure that measured data correspond to the physical motion seen on the video record. They may be used as a backup for loss of time code documentation. Also there are new computer techniques which analyze motion of a structure observed by a video camera. One example is the SUN microcomputer video motion analyse system. Video recording frames may be included in the final report by using a video hardcopy printer.

3.2.4 Analog To Digital Conversion

Edited analog data are converted to digital form and stored on magnetic tape for computer processing. This is done because digital techniques are more suitable for data analysis, data automation, and the use of sophisticated statistical techniques. Table 6 of reference 1 has a sample list of digitizing parameters which must be specified in performing a typical narrowband frequency analysis. This includes the determination of data bit rate and data format. Digitized data are stored on standard IBM compatible 1/2 inch computer tapes with seven or nine track format. Streaming cassette tape cartridges and optical disks might be future means of storing or archiving digital data. Future plans include entering analog data directly into a high speed multichannel analog to digital converter and storing the data immediately on a super disk for instantaneous analysis on the VAX 11/780 using appropriate application software.

3.3 SINGLE CHANNEL TRANSFORMATIONS

Any kind of mathematical operation on a set of measurements is a transformation of the data. This includes mathematical operations like squaring each data point, averaging operations, or multiplying each point in a sequence of measurements by the corresponding point of other sequences of measured or theoretical values.

Data are transformed from one form into another to meet the needs of a specification or to simplify analysis procedures. Data can undergo several transformations. Some are Laplace Transform, Fourier Transform, Analog to Digital conversion and Digital to Analog conversion. Single channel transformation involves only one sequence of measurements. The sequence may be from one location at successive times or at one time from successive locations, (Reference 2, Section 3.2).

3.3.1 Mean Value

If a sequence of measurements is summed and divided by the number of measurements, the result is the arithmetic mean. If each measurement is first squared, the mean square computed and its square root taken the result is the quadratic mean. The quadratic mean is useful when positive or negative measurements give the arithmetic mean a near zero value even for large absolute magnitudes, (Reference 4,Section II, 1).

3.3.2 Standard Deviation

If the arithmetic mean is subtracted from every measurement and the resultant deviations are squared and a mean square deviation computed, the result is the variance. The square root of the variance, or the root mean square deviation from the mean, is the standard deviation. Both the variance and the standard deviation are measures of the dispersion or scatter in the data (Reference 4, Section II, 2).

3.3.3 Skewness

If the deviation of each measurement from the arithmetic mean is cubed and a mean cube computed and divided by the standard deviation cubed, the result is the skewness. Skewness is zero for every set of data in which the positive and negative values are symmetrically distributed. Thus, positive and negative values of skewness are measures of asymmetry (Reference 4, Section II, 3).

3.3.4 Kurtosis

If the deviation of each measurement from the arithmetic mean is raised to the fourth power and a mean quartic computed and divided by the standard deviation raised to the fourth power, the result is the kurtosis. Kurtosis is equal to 1.8 for uniformly distributed data and 3.0 for normally distributed data. Bimodal distributions (a distribution with two modes) have values less than 1.8. Platykurtic distributions (less peaked than normal) have kurtosis between 1.8 and 3.0, and Leptokurtic distributions (more peaked than normal) have kurtosis over 3.0, (Reference 4, Section II, 3).

3.3.5 Fourier Transform (FT)

If each point in a time series of measurements is multiplied by the corresponding point of a superimposed sine wave and a mean of these products is computed, the result is an estimate of the imaginary part of the spectral value for these measurements at the frequency of the sine wave. Replacing the sine wave with a cosine wave results in an estimate of the real part of the spectral value for the frequency of the cosine wave. The Fourier Transform is thus a

complex number with real and imaginary parts at each frequency. For random data it is useful mainly to compute spectra and correlations.

3.3.6 Auto-Spectral Density

The product of a Fourier Transform for a sequence of measurements by the complex conjugate of the same Fourier Transform is the Auto-Spectral Density which is always a real number for each frequency. The auto-spectral density is useful in identifying the frequency composition of time series data. For output data from mechanical (for example, vibration) and electrical (for example, control) systems, this would include resonant frequencies. (Reference 2, Section 3.2.3.)

3.3.7 Autocorrelation

The Fourier Transform of the auto spectral density is the auto correlation. The imaginary part is always zero, so the auto correlation is a real number. It is especially useful in identifying the presence of any periodic signals that might be present in random data, (Reference 2, Section 3.2.2).

3.4 DUAL CHANNEL TRANSFORMATIONS

Dual channel transformation result from computations involving two sequences of measurements. Normally the sequences are from two locations locations measured simultaneously. However, the sequence can be from a set of locations measured at two times. (Reference 2,Section 3.3) Dual channel

transformations are methods of analyzing the interrelationship of two signals sampled over the same time period. The two signals must be sampled at exactly the same instant.

3.4.1 Covariance

If the arithmetic mean of each sequence is subtracted from every measurement in each sequence respectively and the resultant deviations are multiplied and a mean product computed, the result is the covariance. If the covariance is divided by the product of the standard deviations for each sequence, the resultant correlation varying from minus one to plus one is a measure of the similarity of the two sequences, (Reference 2, Section 3.3.1.4, Page 3-81).

3.4.2 Cross Spectral Density (CSD)

The Fourier Transform of one sequence multiplied by the complex conjugate of the Fourier Transform of the other sequence is the cross spectral density. The real part is the coincident spectrum (co-spectrum) and the imaginary part is the quad spectrum, (Reference 2, Section 3.3.3, Page 3-89).

3.4.3 Cross Correlation

The Fourier Transform of the Cross Spectral Density is the cross correlation. The imaginary part is always zero, so the cross-correlation is a real number [AFWAL-TR-85-8030, Section 3.3.2, III-85].

3.4.4 Coherence

The product of the cross-spectrum times its complex conjugate divided by the product of the autospectra for the same two sets of data is the coherence. Ranging from 0 to 1 the coherence measures the degree to which the two sets of measurements can be considered as an input and output for a linear system, (Reference 2, Section 3.3.3.5, Page 3-97).

3.5 DATA PRESENTATION

The last step in the data analysis is to present the results in a concise, understandable form. Plots, tables and pictures increase the interpretability of the results and permit comparisons with similarly computed data. Plots are required for decision making regarding the need for further analysis, testing, and presentation of the results in a final report. Because of the versatility of the digital analysis system, customized programs are written for the users particular requirements.

3.5.1 Single Channel Plots

Plots of single channel data can depict three or more parameters. These parameters are x, y, and engineering units. Normally, x and y are spectral density and frequency or autocorrelation and time. Figures 11 through 15 depict single channel data plots. Axes scaling must be considered. Linear x and y axis (linear/linear), logarithmic x and y axis (log/log), and logarithmic y and linear x axis (semi-log) are some axes scalings shown in Figures 16. The linear axes are selected when peaks in the data are to be emphasized.

Logarithmic axes are selected to compress both axes. Logarithmic axes are scaled linearly as powers of a logarithmic base such as 10. A one-third octave plot as shown in Figure 17 is an example of a log/log plot. The y axis is sound pressure level and is equal to twenty 20log(p measured/p reference). The x axis is frequency and divided into linear one-third octave frequency bands (Constant percentage bands equal to log2(f unknown/f reference).

Envelope plots summarize data to provide a maximum, average, and minimum value for each delta frequency and several data signals. An envelope plot is shown in Figure 18.

Another type of single channel analysis is the probability density function. One way of obtaining a probability density function (PDF), is by first creating a histogram (the number of occurrences in a given band). When you convert the number of occurrences in a given band to a percent of the total number of occurrences, a plot of the probability density function is obtained. Another term for probability density function (PDF) is Amplitude Probability Density Function.

3.5.2 Multiple Channel Plots

The presentation of multiple channel data is the plotting interrelationship of multiple signals sampled over the same time period. The methods described in the single channel plots applies equally well to multiple signals. Linear x and y axis (linear/linear), logarithmic x and y axis (log/log), and logarithmic Y and linear X axis (semi-log) are some of the axes scalings that can be used as shown in Figure 19.

REDUCTION STAGE

Three-dimensional plots depict two independent variables in the xy plane and a third dependent variable in the third dimension or z-axis. Carpet, contour, and waterfall plots are examples of three-dimensional plots.

Crossplots or carpet plots are developed to permit further analyses of the relationship between acoustic and vibration environments during flight tests and laboratory experiments. This program requires as input vibration analyses (such as power spectra) and acoustical analyses (such as sound pressure level spectra) produced by the data analysis system. Then for any frequency band from all the test conditions, it plots acoustic values versus the corresponding vibration values and performs a least-squares fit on the resulting data, producing a graphic presentation of the relationship between the acoustic and vibration environment that can be used for linearity checks and predictions of vibration levels from acoustic levels in certain test situations. Figure 20(a), 20(b) and 20(c) are examples of carpet plots.

Acoustic intensity plots can be utilized for displaying flyover data. The acoustic intensity plot software include options for presenting a time history, a one-third octave band analysis computed every tenth (0.1) of a second during the flyover, a composite maximum spectrum derived from the matrix of overall sound pressure level. These analyses graphically summarizes acoustic characteristics of the aircraft flyover and permits comparisons with other flyovers of the same aircraft at different altitudes and velocities, as well as comparisons with flyovers of other aircrafts. An acoustic intensity plot is shown in Figure 24.

Contour plots are similar to the acoustic intensity plots and used for the same purpose. They differ in that contour plots denotes the intensity levels by curved enclosures. Figures 21, and 22 display examples of the contour and waterfall plots respectively.

A waterfall graph is a display of several measurements plotted versus frequency and related by time. This graph is utilized for nonstationary data (changing with time). This type of graph is called waterfall because it resembles a waterfall in that the several samples of data taken denotes one coming after the other. Figure 22 depicted a typical waterfall graph.

Statistical plots portray a summary of vibration levels for the same location by enveloping the measurement to provide a maximum, average, and minimum value for each delta frequency over a selected frequency range. This type of plot is used when a large number of measurements are taken such as a comprehensive inflight aircraft survey. Figure 23 displays an example of the statistical plot.

A joint probability density function (JPDF), is the percentages of occurrences of two random variables over the same time period. It can also be defined as the number of occurrences at any given time. The JPDF is often presented as a three dimensional plot shown in Figure 25. Joint probability density function is an extension of single channel probability function described above. A Joint Probability Density Function (JPDF) of two random variables is often presented as a three-dimensional plot. The mathematical model for JPDF is defined in the Reference 2, page 3-106.

Often two channels are utilized to derive functions such as cross correlation, coherence, cross-power spectral density, and partial coherence where partial conditional methods of presenting measured data. These functions are plotted using the same axes scalings that were used for single channel data.

3.5.3 Tables

A table is a list of characteristics describing or displaying sets of information for more than four variables or conditions. Titles are placed at the top of the table and use Arabic numbers. For government writing, tables should not have vertical lines around the border of the margin that form a box or square. Horizontal lines are usually permissible within the table except above the title of the table. Sometimes tables supplement plots to present data in a more precise manner. Tables 3 and 4 depict typical FIBG computer generated tables. Tables are relatively easy to generate on computers and word processors.

Table 3 was generated using a microcomputer spreadsheet. The spreadsheet calculated the values in the percent column. After generation of the table, it was uploaded to the FIBG vax computer using a terminal emulator software on the microcomputer. Then it was included in the TM for final print out on the laser printer.

Ideally a table typed into the computer is preferable to a scribbled log sheet that later needs to be transcribed into a final format copy for a report. Frequently computer programs that analyze data are capable of generating tables suitable for inclusion in a report.

3.5.4 Pictures And Video

Pictures and video recordings are accurate tools in describing and documenting tests and research efforts.

3.5.4.1 Pictures -

Photographs are used to illustrate the test set-up and test item. Photographs should be taken of all test items, instrumentation, and test conditions. These photos should be filed in a safe place, preferably with the test file. Pictures can be taken with a personal camera or taken by Tech Photo. Pictures may also be generated using computer graphics displays and cameras to explain a test condition.

3.5.4.2 Video -

Video technology provides new ways to generate pictures and figures for test reports. A standard video recorder can be used to document tests involving motion. Newer video hard copy devices can generate a still picture from the video output video tape recorders, video cameras, test instrumentation, or a computer. Techniques are being developed to produce black and white or color hard copy. FIBG presently has five VHS video tape

recorders, two VHS VCR cameras, three Charge Priming Device (CPD) cameras, a frame synchronizer, three video timers and a variety of other video equipment. Animated computer displays can be copied faster using a video printer than using a standard dot matrix printer. Machines that will reproduce color figures are just becoming available to engineers and scientists.

CHAPTER 4

ANALYSIS STAGE

The distinction between data reduction and data analysis is not clearly defined. An instrumentation engineer may consider generation of a frequency spectra plot as part of the analysis stage. The point of view of the individual conversing influences the definition of data reduction or analysis. The definition of data reduction or data analysis given by an engineer will differ from that given by a mathematician or physicist. This variation should be kept in mind as you read this writing guide.

FIBG data analysis personnel define analysis as the application of the statistical data generated in the data reduction stage to the actual engineering components of the problem at hand in a given project. The engineering group personnel define analysis as drawing engineering conclusions produced by data plots from the Data Analysis Group.

The output of data reduction stage becomes input to data analysis. These outputs include such statistics as the mean, standard deviation, skewness, kurtosis and the data transformations to the frequency domain that constitute the cross spectral density matrices.

ANALYSIS STAGE

Statistics used in the analysis stage were defined in Chapter 3, Sections 3.3 and 3.4, Single and Dual Channel Transformations. These basic statistics are used in this chapter directly, and in combination to describe the dynamic characteristics of mechanical or electronic systems. Also included in this chapter are some means of using collateral, operational, and environmental measurements taken concurrently with vibration and acoustic time series data.

4.1 ANALYSIS OF SINGLE CHANNEL DATA

In the Data Reduction chapter(Section 3.3), seven types of statistic were given for single channel transformations. The first four of these: mean, standard deviation, skewness, and kurtosis are single values that describe characteristics of the entire set of measurements from a single location at a single test condition. The last three: fourier transform, autospectral density, and autocorrelation are functions of frequency or time that describe other characteristics of the same set of measurements. Each of these will be considered in turn.

4.1.1 Mean Value

Ordinarily this is the most used statistics since the single average value best represents a set of fluctuating measurements. In vibration and acoustic data however, fluctuations about a mean value are of primary interest. The mean is often a zero reference level. When the mean is not zero, it can be set to zero by instrumentation systems which are insensitive to the direct current levels. For example, capacitors block the direct current. In some work, means

are subtracted from all the measurements so that its presence will not bias the important statistics below.

4.1.2 Standard Deviation

As defined in chapter 3, the standard deviation is the root mean square (rms) value of deviation of each measurements from the mean - a measure of the fluctuation or dispersion in the measurements. If the mean is zero the standard deviation is simply the overall rms value or quadratic mean the measurements themselves. If the mean is not zero the standard deviation is the square root of difference between the mean square and the square of the mean. Since it measures both the fluctuations and the equilibrium level the overall rms is generally considered the best single measurements of overall vibration or acoustic intensity.

4.1.3 Skewness

As defined in section 3.3.3, the skewness is the mean cube deviation (from the mean) divided by the cube of the standard deviation. A zero value occurs if the deviations from equilibrium occur symmetrically in opposite directions. Such symmetry is implicit in vibration and acoustic theories, so any substantially non-zero value of skewness signals that empirical or non-conventional methods of analysis must be employed.

4.1.4 Kurtosis

As defined in Section 3.3.4, the kurtosis is the mean quartic (4th power

deviation (from the mean)) divided by the 4th power of the standard deviation.) A value of three occurs if the measurements conform to a normal or quassian distribution. Since this is the distribution law assumed for most methods of statistical analyses, any value substantially different from three, signals that further analyses must be undertaken to determine the actual distribution law to which the data conform. The skewness and kurtosis statistics themselves are quite useful in this process. Skewness and kurtosis values for wide range of distribution functions are given in Reference 4. Once the actual distribution law for the measurements is established a mathematical transformation can be determined that will transform the data to new values that are normally distributed.

4.1.5 Fourier Transform

Fourier established that a function can be represented exactly by the sum of a set of sine and cosine waves of varying amplitudes and frequencies. This is useful in decomposing vibration signals into spectral components. For each spectral frequency, the Fourier transform gives the cosine wave amplitude as the real part and the sine wave amplitude as the imaginary part of a complex number. As with any complex number the sine and cosine amplitudes can be converted into a single magnitude times a phase shifted sine wave.

For any periodic data there are a finite number of discrete spectral frequencies. As the period approaches infinity the spectral frequencies become more numerous and closer together approaching a continuous spectral function for non-periodic data. For periodic data, the Fourier transform is the primary

method of analysis for engineering purposes, usually in the polar form where the magnitude is the amplitude of the sinusoidal component and the polar angle is the phase shift. Autospectral density is normally employed as the chief method of engineering analysis for non-periodic data.

4.1.6 Autospectral Density

As noted in section 3.3.5, the Fourier transform times its own complex conjugate is the Autospectral Density(or PSD). For any complex number this product is always real. Therefore, the phase information is lost, and the autospectral density is simply the square of the magnitude of the polar form of the Fourier Transform. The autospectral density which is the spectral composition of the time data, is the chief measurement employed in engineering applications. If, for example, a lightly damped structure has a resonant response at some frequency, the autospectral density of measurements from that structure would show a sharp peak at that same frequency when excited at resonance.

4.1.7 Autocorrelation

As noted in section 3.3.7, the Fourier transform of the Autospectral Density is the Autocorrelation. It is real due to special characteristics of the autospectral density. The autocorrelation is useful to distinguish between two types of spectral peaks. One of these types results, from a resonant response to a low or moderate excitation. For this type, the autocorrelation approaches zero at large values of time. The other type of spectral peak

results from an exceedingly high excitation at the frequency of the peak due. For example, an unbalanced rotational motion of a wheel will cause the system to vibrate at the frequency of rotation. For this type, the autocorrelation will approach a periodic function at large values of time. In essence, a severe response can result from low excitation at a resonant frequency or high excitation at a nonresonant frequency..

4.2 ANALYSIS OF DUAL CHANNEL DATA

In the Data Reduction chapter (Section 3.4) four types of statistics were given for dual channel transformations: covariance, cross spectral, cross correlation , and coherence. The first 3 of these are the basic statistical quantities used to compute a variety of other functions of engineering interest. These are the cross spectral density and cross correlation matrices.

4.2.1 Coherence

For linear systems, the coherence between an excitation and the response between any two points will always be equal to one at all frequencies. Likewise, with the same excitation the coherence between any pair of response points will also be equal to one for at all frequencies. If the coherence is less than one at any frequency, either nonlinearities, noise, or other excitations are present in the system. Any coherence measurement that exceeds one indicates errors in data processing operations, since the mathematical formulation does not permit coherence to ever exceed one at any frequency.

4.2.2 Frequency Response Function/Transfer Function

For any linear system the cross-spectrum between an input and an output divided by the input autospectrum is the Frequency Response Function. Alternatively, it can be defined as the Fourier Transform of the response of a linear system, to a unit impulse function.

The Frequency Response Function did not appear in chapter 3 because those statistics were computed for all individual or all pairs of measurement sequences whether they were excitation or response data. The frequency response function cannot be an automatic output of routine data processing operations because its computation requires identification of excitation input data and response output data. This involves an engineering knowledge of the test item from which the measurements are being taken.

Since the frequency response function is the output per unit input, it defines the dynamic characteristics of the system, and this is the factor of primary interest in most engineering applications.

The Laplace transform of the response of a linear system to a unit impulse function is the Transfer Function. For an undamped system it is exactly or the same as a Fourier Transform. For these reasons, the two are often used interchangeably.

4.3 ANALYSIS OF MULTIPLE CHANNEL DATA

Multiple Channel Transformations result from computations involving more than two sequences of measurements. Normally the starting point is the

spectral density matrix in which all diagonal positions represent autospectra and all off diagonal positions represent cross spectra. Cross spectra on opposite sides of the diagonal which are complex, conjugates one another. Clearly, the matrix is square with row and column numbers representing the measurements sequences being considered. Generally, the different sequences represent different locations or sometimes different directions for the same location. There is of course, a separate matrix for each frequency. These matrices can be marginal or conditional for spectral data. (Reference 2, Section 3.4, Page 3-105)

4.3.1 Marginal Functions

In multiple channel computations, marginal value or functions are simply those computed for some measurement sequences while ignoring others. Every element of the spectral density matrix is a marginal spectral value since all other elements are ignored. (Reference 4, Page 72). Likewise, every sub-matrix is a marginal matrix. In fact, even the initial matrix can be considered a marginal matrix since it does not include measurements from points which were not instrumented. Since every matrix is a marginal matrix, this term(marginal) is used to distinguish a marginal matrix from the conditional one defined below.

4.3.2 Conditional Function

In multiple channel computations, conditional spectral densities(values or functions) are those computed to statistically subtract out the effects of

other sources of excitations. In the spectral density matrix this statistical adjustment is performed by: (1) inverting the entire matrix, (2) deleting the rows and columns representing the excitations to be deleted, and (3) reinverting the smaller matrix. In this smaller matrix each spectral value is the result that would be obtained in a linear system if the inputs represented by the deleted rows and columns had been zero. (Reference 4, Page 72).

4.4 STATISTICAL MODELS

Associated with each set of dynamic measurements are a host of variables describing system operation, location characteristics, test conditions, and environmental factors. A change in any of these variables may strongly affect one or more of the previously described characteristics of the dynamic measurements being taken. This section describes how these affects can be quantified.

Statistical models are derived from statistical theory applied to measurements. Theoretical models are derived from physical theory which could include shock, vibration, and acoustics. Empirical models are based on practical experience rather than theory.

4.4.1 Factor Analysis

The statistics previously defined: mean, standard deviation, skewness, kurtosis, and various spectral values - all describe characteristics for one set of univariate measurements from one sensor. In general, instrumentation systems involve several sets of data from many sensing devices. There are the

problems of reducing one large set of measurements to a few descriptive statistics. In addition, there is the problem of reducing a large number of interrelated sets or variables into a smaller number of independent factors. The purpose of factor analysis is to determine this structure of interrelationships among sets of interdependent data.

In general, multiple sets of data will contain measurements of different physical quantities in unlike units. Therefore, the data must be standardized before any relationships can be computed. Each set of measurements is standardized by first subtracting the mean of the set from each measurement, and then dividing the result by the standard deviation. If the measurements are taken in pairs - one to each set - then, the mean of the cross-products of corresponding standardized values is the correlation. A correlation equal to one indicates that the two sets are essentially the same, differing only in the reference point and scaling unit. A minus one (-1) correlation implies a fixed fall in the one variable per unit rise in the other variable. Zero correlation indicates no relationship between the two variables.

For many sets of measurements there will be many correlations. These can be arranged into matrix form in which data sets are represented by rows and columns. Diagonal positions are always equal to one since they represent the correlation of each data set with itself. The off diagonal position represent the correlation of data sets corresponding to the row and column numbers. The matrix is, therefore, symmetrical about the diagonal.

In factor analysis the diagonal elements are first replaced by values which minimize the rank of the matrix. The resulting array is then decomposed or factored into the product of a new matrix and is transposed in such a way that its elements a(ij) have the largest possible variance (this is possible since the factorization is not unique). These elements are the loading coefficients for approximating each variable Z(i) in terms of a linear combination of a few uncorrelated common factors F(j), specifically: Z(i) = a(i1)F(1) + ... + a(ij)F(j). Since their variance is maximized, the a(ij) will tend in absolute value to be very high (equal to 1) or very low (equal to 0). Now if the sequence of variable in the correlation matrix is reordered so that only those heavily loaded on the first factor appear first and only those heavily loaded on the second factor appear second, and so on; then, the highest absolute correlations will appear in blocks along the diagonal with low correlations elsewhere. The remaining rows and columns of the correlation matrix will include highly correlated variables due to moderate loadings on two or more factors, and lowly correlated variables due to low loadings on all factors.

The row and column variables associated with each high correlation block respond to variations in nearly the same way. The reason for such response patterns may be identified by examining all system characteristics to find those attributes which tend to be comparable for within block variables and contrasting for between block variables. The set of attributes associated with each block, after suitable verification and refinement, may then be incorporated into some more sophisticated statistical modeling function.

The mathematical formulation and an example of Factor Analysis is set forth in Reference 4, page 80.

4.4.2 Analysis Of Variance

Vibration and acoustic measurements can be arranged into an array or matrix in which each column represents one of the sensor locations and each row represents one of the test conditions at which measurements were made. The mathematical expression for representing each measurement by the sum of a general term, column effect, row effect, and an interaction term is given as follows:

4.1 $$V(ij) = a + b(i) + c(j) + db(i)\,c(j)$$

where

V(ij) = measurement at location i condition j

a = mean value over all locations and conditions

b(i) = location i effect

c(j) = test condition j effect

d = interaction constant

This models ij measurements in terms of i + j statistics: a, b(1)...b(I-1), C(1)...C(J-1), and d. (Since the b(i) and c(j) sum to zero, there are only I-1 independent values of b(i) and J-1 independent value of c(j). Thus, if there are 60 locations and 20 test conditions, there are 60 x 20 = 1200 measurements modeled in terms of 1 + 59 + 19 + 1 = 80 statistics, a reduction of 93%, (80 =

7% of the 1200 measurements). A theoretical treatment of this model is given in reference 5.

The mathematical operations required to compute the statistics in equation 4.1 are given as follows:

(1) Form a data matrix in which each column represents a sensor location, each row represents a flight condition, and each cell contains a measurement for that location and flight condition.

(2) Compute the mean value of all elements in the matrix to get the general term, a.

(3) Subtract the general term from each cell measurement and use the resulting matrix to compute all column row means. These are the location effects, b(i), and flight condition effects, c(j), respectively.

(4) From each cell measurement (from the original matrix), subtract the sum of: the general term + the location effect + the flight condition effect, to obtain the cell interaction effect. Also, for each cell compute the product of its location effect and its flight condition effect.

(5) In each cell, (1) multiply each interaction effect by the product term and sum over all cells, (2) square each product term and sum over all cells, and (3) divide the first sum by the second. This is the general interaction constant d that multiplies the product of the location and flight condition

effects in the modeling function.

(6) Finally, to obtain the matrix of true interaction effects (those not due to the choice of the scale of observation) + the measurement error, subtract from each cell measurements in the original matrix, the sum of: the general term + the location effect, + the flight condition effect + (the general coefficient times the product of the location and flight condition effects). (If the cell measurement is the mean of several observations, this is the true interaction matrix and the measurement error is given separately by the difference between each observation and its cell mean).

4.4.2.1 Extended Application Of The Analysis Of Variance (ANOV) Model Function

Once the location effects b(i) and the test condition effects c(j) have been computed either may be further decomposed into one or more of its constituent components. For example, if triaxial sensors are placed in several positions, the location effects can be represented by a mathematical model analogous to equation 1 above but with redefinition of all variables and subscripts.

4.2 $V(ij) = a + b(i) + c(j) + db(i)\ c(j)$

$V(ij)$ = location effects at position i direction j

a = mean over all positions and directions

$b(i)$ = position i effect

$c(j)$ = direction j effect

d = mean interaction constant

For a second example, if measurements are taken during straight and level flight at various combinations of airspeed and altitude, the test condition effects can be represented by a quantitative extension of equation 1 again with a redefinition of all variables:

4.3 V(x,y) = a + bx + cy + dxy + fx(**2) + gy(**2)

x = airspeed (measured minus mean)

y = altitude (measured minus mean)

V(x,y) = test condition effects

a,b,c,d,f,g = regression coefficients.

CHAPTER 5

REPORT PREPARATION STAGE

This chapter of the report writing guide is designed to help prepare technical reports and memorandums. This chapter discusses the post test meeting, report format, word processing technologies, and what is available in FIBG. Brief descriptions of each process will be given with reference to a more detailed manual to instruct how to use and accomplish your task.

5.1 POST TEST MEETING

The post test meeting should be conducted soon after test completion. Everyone involved in the test program should attend this meeting to all answer all questions in a joint forum. At the post test meeting, all lessons learned should be recorded to expedite future test efforts. The project engineer or person recording the minutes should write a brief summary of all lessons learned. This summary should be filed in the project file for future use in similar projects. A copy of this document should be filed in a central branch file or computer directory for use by all branch technical personnel if assistance is needed for conducting future tests. Additionally, a total cost of the test containing temporary duty (TDY), manhours, overtime, supplies and

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equipment required should be included for future estimates in similar tests.

The following questions should be asked and discussed at the post test meeting.

1. Why was this project undertaken?
2. How did this program fit into the big picture?
3. What was the basic problem?
4. What were the unusual or unique processes or activities undertaken?
5. What facilities and instrumentation were used?
6. What problems arose during the work and how were they overcome?
7. What are the best types of data to indicate your results?
8. What were the significant results?
9. What is the spelling of "each" person's name involved in the test?
10. What type of report should be written?
11. Who will be responsible for the report?
12. Who will be contributing authors for the report?
13. Define the various sections that will be included in the report?
14. What format will be used for chapter titles, appendices, etc.?
15. What are the reviewer's expectation in this report?
16. Who is interested in receiving a copy of the printed document?
17. What was accomplished?
18. What were the significant results?
19. What are the possible benefits and uses in the future research from this program?
20. What are our weaknesses in technical knowledge, equipment and facilities for this type of testing?

21. What are your recommendations for conducting the same or a similar test in a more successful and productive manner.

22. What were the deviations from the test plan?

5.1.1 Format Standards(MIL STD 847-A)

Military Standard 847-A (Reference 6) implements the Department of Defense (DOD) "Guidelines to Format Standards for Scientific and Technical Reports prepared by or for the Federal Government" developed by the Federal Council for Science and Technology, Committee on Scientific and Technical Information (COSATI), Panel on Operational Techniques and Systems. The standard provisions are mandatory for contractor or grantee reports. It is is approved for use by all Departments and Agencies of the DOD.

5.1.2 Research And Development Preparation Of Technical Reports

The pamphlet AFWAL P-80-1(Reference 7) assists engineers, scientists, and technicians to prepare in-house and contractor generated technical reports. Check with AFWAL/IMST-FI for the latest version. Also, a copy of STINFO guidelines is included as Appendix G.

5.1.3 Distribution List

A distribution list is a roster of all personnel or organizations including mailing addressees, who will receive a copy of this document. This list is usually the last page of the technical memorandum. For a technical report, labels have to be constructed and included with the final publication.

A branch distribution list is available on a Zenith 100 hard disk which is located in FIBGC Room 213 or FIBGD Room 10. This list can be edited, updated or tailored to your specific needs. Instructions to use this tool are located near the Zenith 100 computer. The branch distribution list utilizes the list manager program of Peachtex software. If complications arise contact AFWAL/IMST.

5.2 WORD PROCESSING TECHNOLOGIES

FIBG possess four dedicated word processing systems. They are an IBM Display Writer (FIBGC), located in Room 213 and three DEC Mate Word Processors located in Rooms 210, 220, and 10. Manuals are located near these systems. The VAX 11/780 also has word processing capabilities and can be routed to a letter quality laser printer. The final draft of a Technical Report can be printed on the DEC-Mate printers to be compatible with optical character reader(OCR) equipment display writer. The final copy of a Technical Memorandum or Paper can be printed on any letter quality printer.

5.2.1 Text

The text for a report can be generated in many ways. A handwritten draft can be given to a secretary for typing, and after several iterations the typed report is produced. An author may type the report on a typewriter. New techniques involve typing reports using a dedicated word processor, or a computer text editor or word processing programs. These new techniques are being used by secretaries and authors in the branch. A large number of

computers and word processors are available for use by FIBG personnel. Dedicated Word Processing Machines are the DECmate and IBM Display Writers. Computers usable for word processing are the VAX 11/780, Zenith Z-100, HP 9816-S, Commodore 8032, Radio Shack Model 100, MASSCOMP, Compac, HP 9836-S, microVax II and others that are planned for future procurement. These computers have a rich variety of word processing techniques including text editors, text formatters, and typesetting programs.

5.2.2 Tables

Tables are useful tools in displaying several variables, conditions or analysis results. Tables can be generated on all computer systems in the Branch. Handwritten tables should be typed into a computer for report ready formatted printout in a minimum amount of time. Tables can be generated when setting up a test matrix of conditions for a project. Other tables may be generated as printouts resulting from computer computations. In TRs and TMs, horizontal border lines are not permissible. However, this is not a standard for all publications such as conferences and magazines. Some publishers allow these lines; but most will not. Example of tables most generated by FIBG are shown in Tables 2,3 and 4.

5.2.3 Equations

Equations are the basis for analyses and data reduction. Through programming techniques the majority of all mathematical computations have been computerized. It is difficult and time consuming to printout equations in

reports using typewriters if several iterations are needed. It is more feasible to type reports on a word processor or computer. Typesetting programs, such as TEX on the Graphix VAX 11/780, prints out complex equations in quality report ready format. An example of complex equations are shown in Figure 26, which is a page from reference 8.

5.2.4 Figures

Sketches, diagrams, and flowcharts are usually hand drawn for inclusion in a report. Data plots generated by computers are also a source of figures. Sketches and diagrams can be drawn by using new computers rather than pencil and paper. Currently a wide variety of systems are used in FIB, but there are no known standard system for integrative graphics and text. One branch has a MacIntosh computer and laser printer for desk top report generation. The Grafix VAX has a program called PISCURE which generates high quality figures. Some of the microcomputers include CAD/CAM packages which produce detailed mechanical drawings. The new technology provides a diverse number of ways of generating figures.

5.2.5 Photographs

Many times still photographs are incorporated into a report to help clarify test description or test conduction. To request Tech Photo take pictures, call 54085 and make an appointment. You may take your own still photographs and have Tech Photo do the development and processing of the film. Always take photos of the test items and instrumentation should be taken for

later reference and inclusion in the report.

In recent years, video recorders and computers have provided new means of incorporating pictures in a technical report. A video cassette recorder (VCR) can record the events of a test as desired. Later, the video tape can be reviewed to recall test configurations and instrumentation setups that were used when test participants have conflicting views of what occurred. Since video recording is relatively new technology, there are many unforeseen methods and techniques that can be used to help shorten the time in preparing a report. One example is to use a video digitizer and a microcomputer to convert a desired video frame into a hard copy print for inclusion in your report. A new video motion analysis work station is one new tool that FIBG has just received. In addition to test documentation, video can be used to make non contacting measurement of displacements and other measurands.

5.3 WHAT IS AVAILABLE

A large variety of new computer systems and software is available to FIBG. Hardware and software available to help generate high quality reports are listed in Tables 5 and 6.

CHAPTER 6

PUBLICATION POLICIES

There are several ways technical information can be reported. The technical report is selected for widely distributed publications, like reporting the results of a contractual effort, closing out in-house work units, and other information of this magnitude. The technical memorandum is distributed at a lesser degree, and may be selected for system support efforts and interim in-house reports. Technical papers are written to present information to the technical community in conference proceedings and technical journals. This chapter introduces various ways in which publications begin the journey to being cleared and published. However, these methods and procedures vary with organizations, but the principle is the same.

6.1 TECHNICAL REPORT (TR)

A technical report (TR) is the documentation written after completion of a test or research study. The TR is of interest to a vast number of people in the technical community. The TR should include the following 6 sections: Forword or Preface, Introduction, Method and Procedures, Analyses, Conclusions, and Recommendations.

6.1.1 Front Cover

The front cover will include the following information:

Report Number - will be assigned after a draft has been approved and is submitted for editing;

Title and Subtitle - shall indicate clearly and briefly the report subject;

The author(s) - The person(s) responsible for writing the report;

The organization - that the author(s) are employed in, (maximum, two level hierarchy, such as Structural Dynamics Branch, Structures Division);

The date - month and year the report is completed, and the period it covers;

The type of report - final, interim, draft;

Distribution statement - states who is authorized to receive a copy and how many may be distributed;

Monitoring agency - is the complete identification including zip code of the organization performing the work; An example would be:

Flight Dynamics Laboratory
Air Force Wright Aeronautical Laboratories
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio 45433-6553.

The organization emblem is placed in the upper right hand corner and is usually positioned on the cover by Publication. All classified reports should be

marked "classified" at the top and bottom of both front and back covers, along with the appropriate level of classification markings, such as Secret and Top Secret. Classified markings change frequently and the Security Office should be contacted for the most recent format for classified reports.

6.1.2 Notice Page

The Notice Page is the back page of the front cover. An example of the notice page is displayed in Figure 27. The signatures on this page should be the author(s), Branch Chief, and Division Chief. The Division Chief signature should be the last signature on the page.

6.1.2.1 Report Documentation Page (DD Form 1473) .p;The DD Form 1473 Should Be completed and will include the report classification at the top and bottom of the form. A sample of a completed DD Form 1473 is shown in Figure 28.

6.1.3 Parts Of A Report

A technical report should include some standard sections. A suggested outline for a report could be: (1) Introduction, (2) Instrumentation, (3) Test Procedure or Experimentation, (4) Data Analysis, (5) Results, (6) Conclusions and/or Recommendations.

6.1.3.1 Introduction -

The introduction should orient the readers to the content of the study that has been conducted. It sets the stage and provides reliable information to the facts being documented. The first sentence of this section should be a stage setting statement. This statement should focus the reader's attention on the subject of the report. The introduction usually guide the reader into the shaping of the remaining sections of the report.

6.1.3.2 Instrumentation -

The instrumentation section of a report gives the name and types of equipment used to conduct the study.

6.1.3.3 Test Procedure/Experimentation -

This section describes the steps taken to conduct the study. It should include the test conditions, equipment setup, and all changes or variations to the test plan. There should be enough information in this section to duplicate the test and its setup in its entirety.

6.1.3.4 Data Analysis -

The data analysis section should include the procedure taken to analyze the data, mathematical models used or developed for this study and the reason for choosing this technique. This section should point out any outstanding or shortcoming of the data that may be misunderstood.

6.1.3.5 Results -

The results section contains the consequences, calculations and investigations stemming from the study. This section convey a message in support of the purpose of the report. It should include the main ideas about the subject and supporting details that clarify the study or experiment. There may be times when the results may not be conclusive and further study is needed. These results are particularly important in order for the procedure not to be duplicated and other methods can be explored. The results section of a report is usually the answer to the problem or study, and may be considered the most important section of the report.

6.1.3.6 Conclusions -

The conclusion is similar to the results section and sometimes are combined together. This section interprets the results and usually offers a suggestion or recommendation to the problem or study. It assures the reader that the purpose of the report have been accomplished as stated in the introduction. The conclusion should close the report with statements based on your preceding discussion. It is always the last section of the report.

6.1.4 Review Chain Of Command

The Review Chain of Command is the order of management hierarchy (least to the greatest). Upon completion of the final TR draft, a copy is distributed to the group leader and branch chief respectively. After receiving their corrected copies or responses, the necessary corrections are made and

incorporated into the draft. Several iterations may be necessary while moving through the chain. See Figure 29.

6.1.5 Review Committee

The Review Committee is recommended to the division by the author(s) and consists of at least three people. At least one person on this committee should not be a member of the author's branch. The selection should be comprised of people knowledgeable of the subject matter. One committee member is identified to be the chairperson. The author supplies the chairperson of the committee a copies of the corrected draft report. The chairperson distributes a copy of this report to each member.The chairperson reserves a meeting place, sets the meeting dates and times and assimilates the review committee's remarks, corrections and suggestions. The chairperson prepares a cover letter and a draft of the report consisting of the review committee corrections and remarks. The cover letter summarizes the review committee responses and recommendations and is addressed to the author(s) of the report.

6.1.6 Information Management Scientific Technology, AFWAL/IMST

The Information Management Scientific Technology organization, commonly known as the Science and Technical Information (STINFO), assigns report numbers for technical memorandums and reports. AFWAL/IMST (STINFO) is the focal point for questions concerning reports and report writing. When a report is completed it is submitted for editing and printing through the IMST Office (55197), located at Building 22, Room H-125. A sample letter of request for a

technical report number is shown in Figure 30.

6.1.7 REQUEST FOR CLEARANCE LETTER

If a publication requires unlimited distribution, a request for clearance letter should be completed and sent to ASD/PA through the IMST office. A form letter for clearance of a TR is shown in Figure 31.

6.1.8 REQUEST FOR EDITING LETTER

After the final document has been written, a request for editing of the draft technical report is accomplished by completing an AFSC Form 2649 and is shown in Figure 32.

6.1.9 Summary Of The Procedures Once The Technical Report Is Written

After the preliminary report is reviewed by other authors and group leaders, it is submitted to the technical review committee. A letter recommending review committee members and a chairperson should be written for a Division endorsement. Then copies of the report should be made for the review committee chairperson and each member. With these copies a signature form (Figure 31), should also be given to the committee chairperson. The committee chairperson and its members review the draft and incorporate comments into one copy of the draft and prepare a letter with recommendations. The author then incorporates these comments and suggestions into the draft. The next step is to prepare a letter requesting technical editing and a report number (AFSC Form 2649). This form is submitted to AFWAL/IMST. Also, if you want unlimited

distribution, prepare a Request For Clearance letter for submittal to ASD/PA through AFWAL/IMST. When the report returns from editing, it is ready for signatures by the author(s), branch chief review committee chairperson and the Division. The Division signature is the final signature of the technical report. At this time, address labels required for mailing the reports should be prepared. Currently, a branch distribution list is maintained on a Z-100 floppy diskette. This list may be modified to meet the author's needs. The labels are submitted at the same time as the final technical report is forwarded for division signature. The review committee form with signatures is also sent to the division at this time. A copy of this form should be maintained for the author's files. After the division signs the TR it is sent to technical editing group (AFWAL/IMST), for printing and distribution.

A great deal of of time is involved from the writing of the first draft to the distribution of the final technical report. The total time can range from 18 weeks several months. Preparation of the first draft for the review committee can take several weeks to several months, depending on the author's writing ability and workload; and also the complexity of the report. The review of the draft by the technical review committee may take from one (1) to six (6) months. Editing takes anywhere from 6 weeks to 5 months after submittal of the Request for Editing letter. After the report is returned from editing and a camera ready copy is obtained, it may take one to five weeks to get the final review committee signatures, division signature, and address labels ready for submittal to be printed. A period of six weeks to five months may occur before distribution of the final report.

PUBLICATION POLICIES

One important factor in expediting a report being published is to screen the reviewer's workload carefully, making sure that that individual have some time to review the report and return the document by the allotted time given by the author(s). This is not always possible, but should be attempted more often than not.

The steps outlined above assume that an in-house TR is being written. For contractor generated TR's, there is no review committee. The project engineer takes the place of the review committee and perform a careful review of the TR. The contractor makes the actual corrections to the TR using guidance provided by AFWAL/IMST.

A Summary of the Procedures for writing a Technical Report is shown in a block diagram of Figure 34. At this point, the technical report is published and distributed to the specified individuals or organization.

In order for FIBG to publish a Technical Report in a timely manner, the timetable should be thus:

Preparing the first draft - Twelve weeks maximum.

Reviewing of the Report by group leader - One week.

Technical Committee Review - Four weeks maximum.

Incorporation of Suggestions - One week maximum.

Editing with a diskette - Six weeks maximum.

Without a diskette - Eight weeks maximum.

Division Signature - Two weeks maximum.

Printing and distribution - Eight weeks maximum.

From start to finish should take a maximum of 42 weeks.

6.2 TECHNICAL MEMORANDUM

A technical memorandum (TM) is a report of transient or limited interest or an interim step in writing a technical report. The distribution lists for TM's are not as extensive as the technical reports. The TM distribution list is included in the report. Technical Memorandums are usually reports that are of interest to a select number of people and needed to make decisions quickly. The length of TMs varies from project to project or effort to effort depending on the complexity. TMs can be signed by the branch chief and should take no longer than 90 days from start to finish.

6.2.1 REVIEW CHAIN OF COMMAND

The TM is reviewed by the co-authors, group leaders, and branch chief, respectively. After receiving their corrected copies or responses, the necessary corrections are made to the draft. See Figure 34 for a flowchart of the technical memorandum process.

6.2.2 SCIENCE AND TECHNICAL INFORMATION (STINFO)

A letter requesting a TM Number is written at this stage and mailed to AFWAL/IMST-FI. This letter is signed by the project engineer or primary author and the branch chief. A sample letter is shown in Figure 36.

6.2.3 REQUEST FOR PUBLIC RELEASE

For unlimited distribution, a letter requesting public release should be

sent to ASD/PA through AFWAL/IMST. A form letter is shown in Figure 31.

6.2.4 REQUEST EDITING AND PRINTING LETTER

Editing and printing a TM is not usually the same as for a TR. For a TM, IMST prints exactly what you send them. No editing is performed. IMST fills out the form instructing the number of copies to be printed. Currently there is a limit of fifty (50) copies. This usually takes 4 to 6 weeks to receive the printed TM for distribution. Distribution is made by the author. The alternate approach is to accomplish printing of the final TM on your own. This would require an individual to make the copies and mailing them to the respective people on the distribution list. This method is usually employed when the report is of interest to a small number of companies or individuals, such as 10 or less.

6.3 SYMPOSIUM PAPERS AND JOURNALS

The processing symposium papers is usually dictated by the sponsoring organization. This includes the length and format. Clearance approval is required by the FIB Division and ASD/PA. If the paper is going to be presented, the author makes a preliminary briefing to the FIB Division before giving the final presentation.

6.3.1 REVIEW COMMITTEE

The review committee is optional and very informal. However, this Committee can be beneficial in publishing quality papers. Of course, this

could cause a time delay in the publication of papers.

6.3.2 CHAIN OF COMMAND

The publication or presentation of a symposium paper outside of the FIB division requires a group leader, branch chief, and division office review.

6.3.3 REQUEST FOR PUBLIC RELEASE

For unlimited distribution, a letter requesting public release should be sent to ASD/PA through AFWAL/IMST. A form letter for this purpose is shown in Figure 31. This letter must be signed by the division with the approval of FI if the paper will be presented orally. The author is responsible for scheduling a practice briefing with Division representation. You should allow 20 days to obtain approval for public release. Also, if your subject matter includes sensitive topics, additional time is necessary to obtain commands approval.

6.3.4 FOLLOW HOST PUBLISHER INSTRUCTIONS

Each publisher requires a specific format and provides the instructions and procedures to follow. In following these instructions, it may require typing the text on mats or other special formatted paper contents.

APPENDIX A

REFERENCES AND BIBLIOGRAPHY

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A.1 REFERENCES

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APPENDIX B

FIGURES

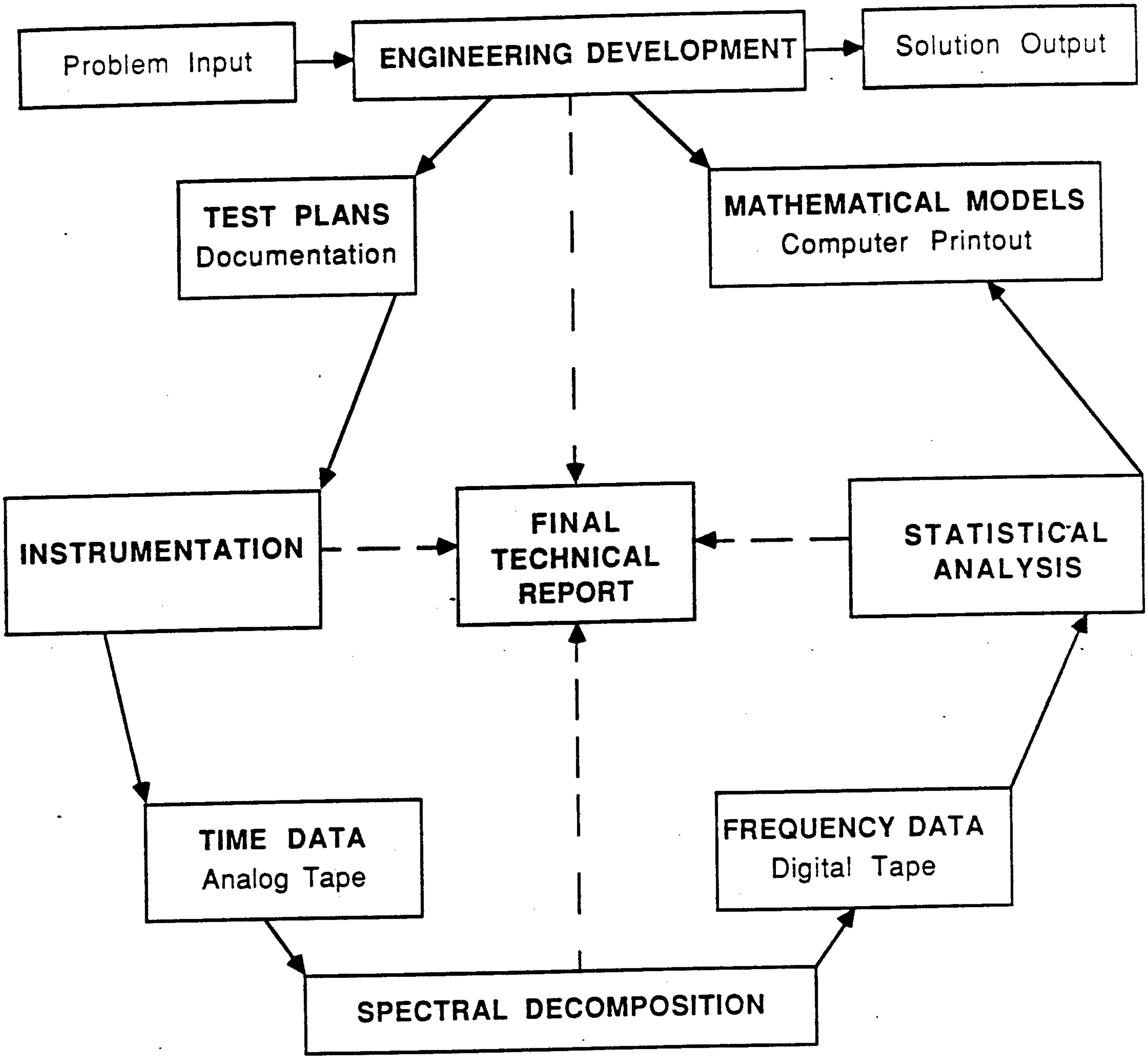


Figure 1. Technologies In Measurements And Analysis.

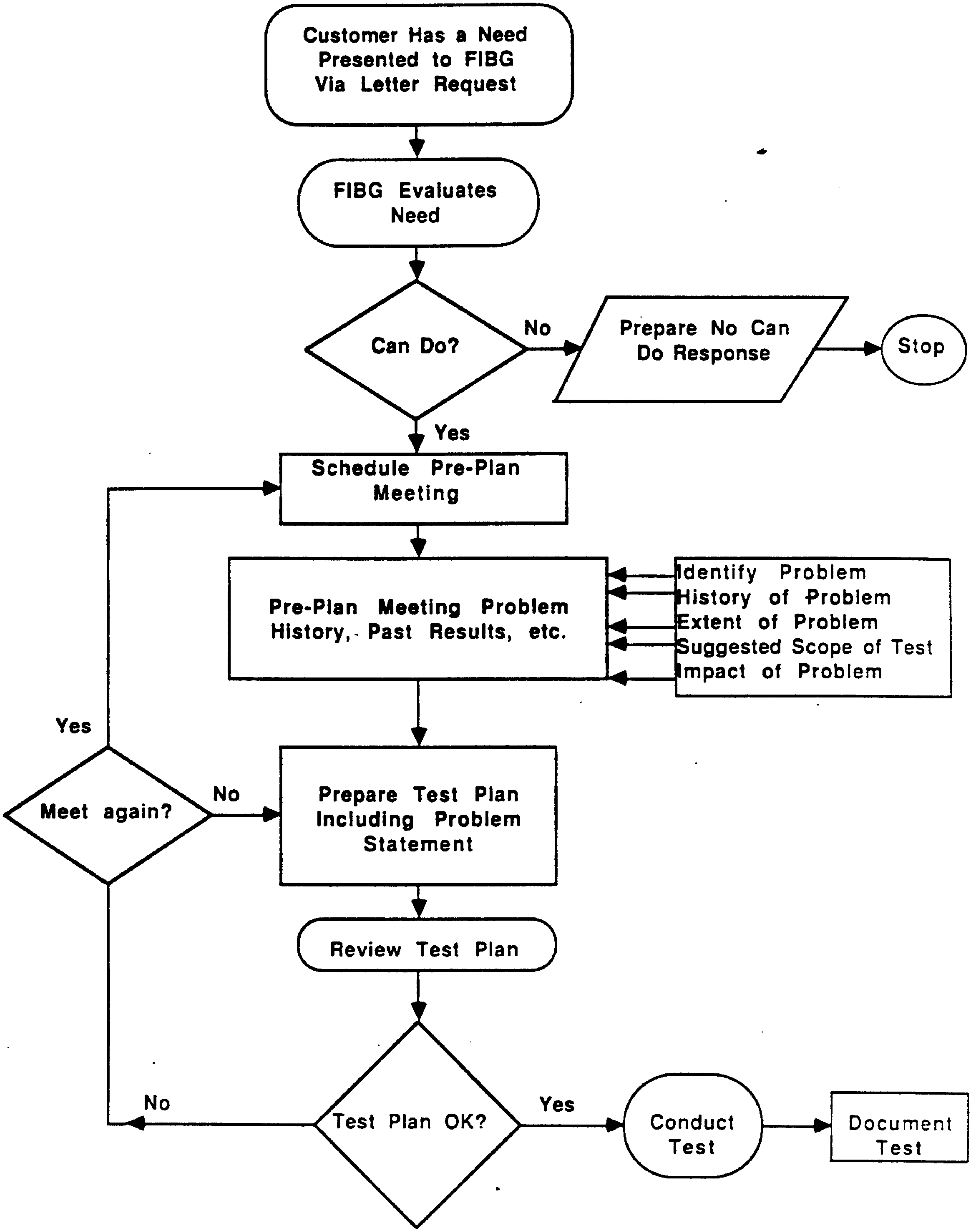
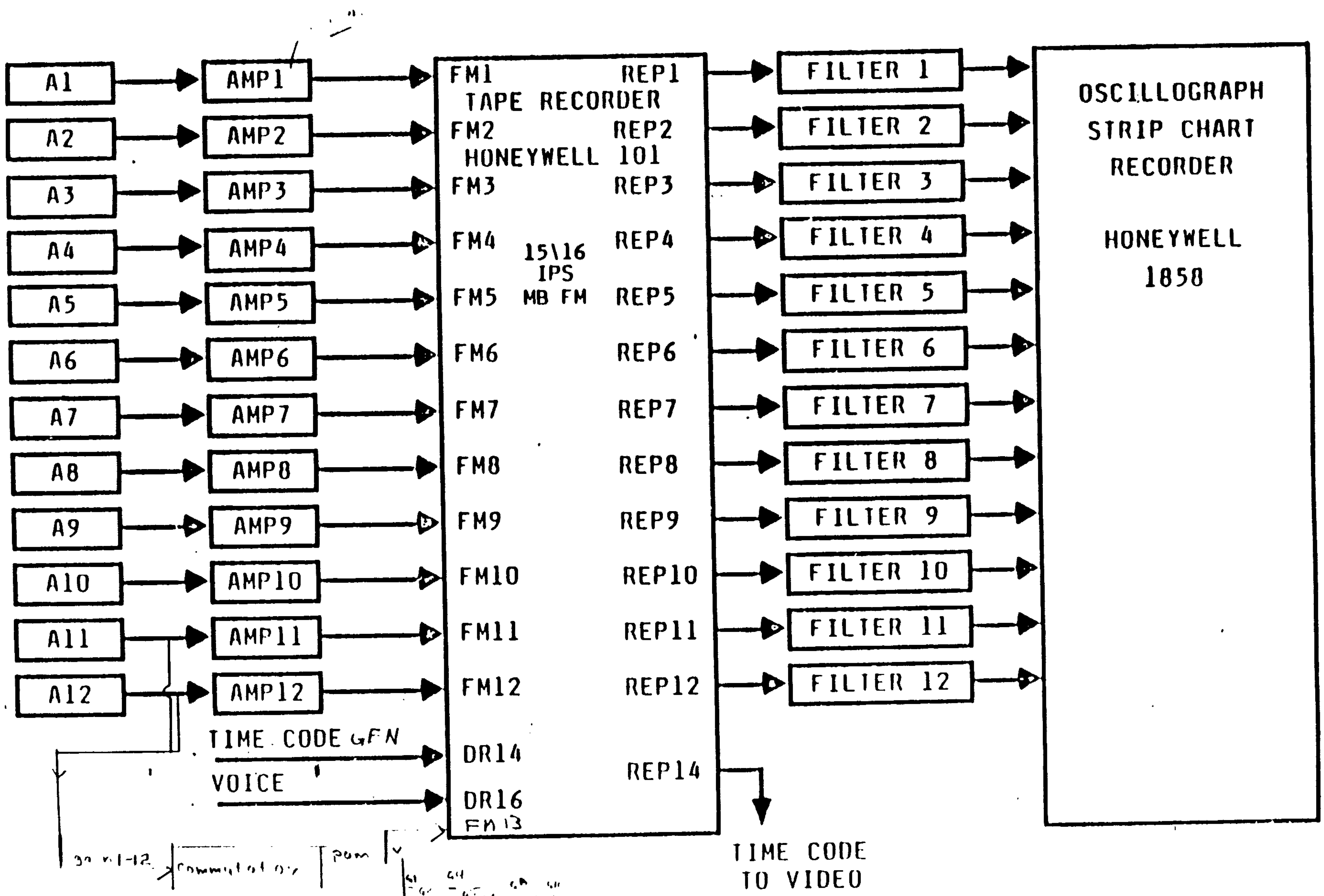


Figure 2. Procedures For Conducting In-House Tests.

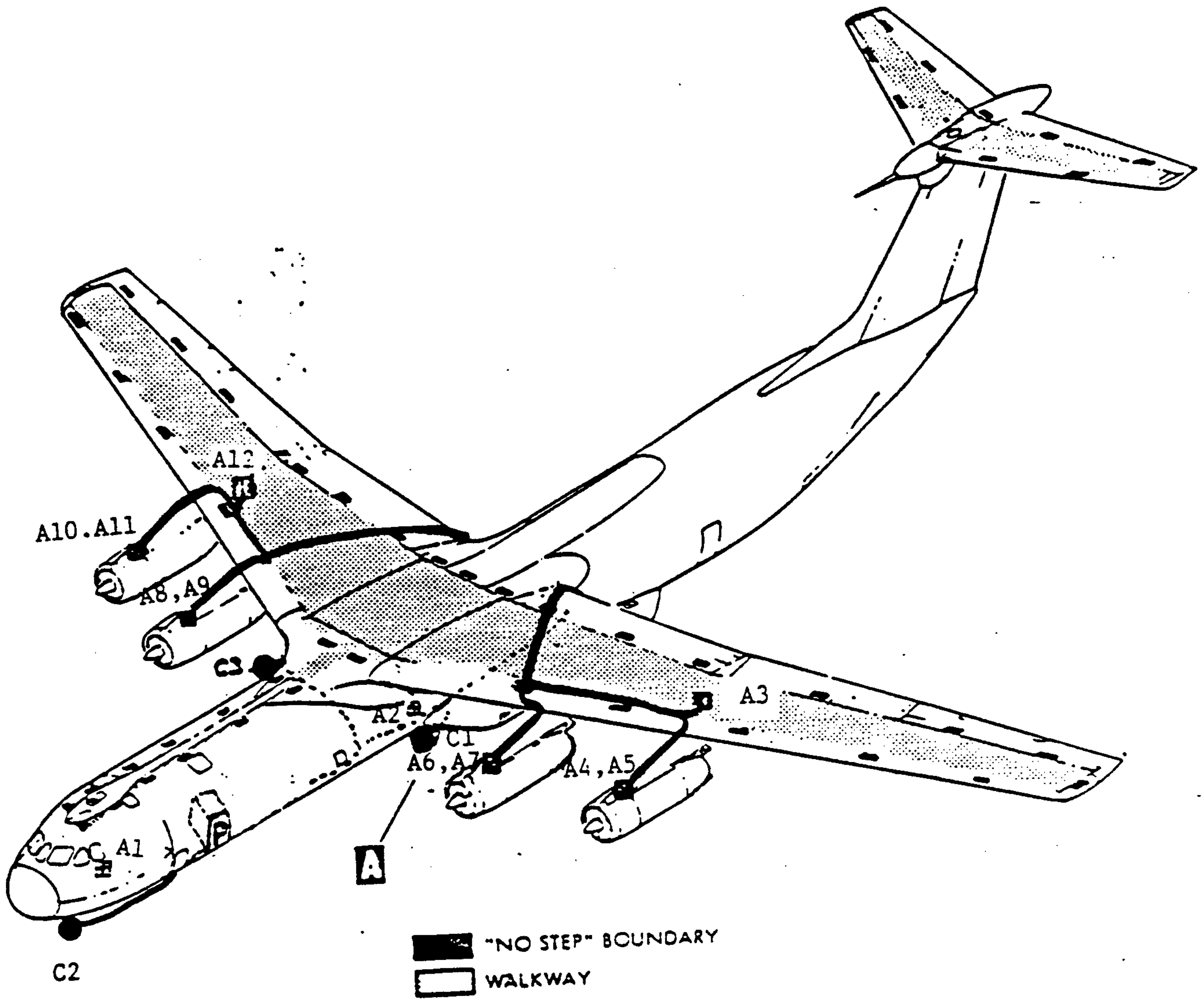
Test Program			
Jane Doe	GS12/01	$31,619 x 120/2087 hours =	$1818.05
Mike Smith	GS-08/01	$19,740 x 120/2087 hours =	$1135.26
Preparation of Test			
Jane Doe	GS12/01	$31,619 x 80/2087 hours =	$1212.04
Mike Smith	GS-08-01	$19,740 x 40/2087 hours =	$378.34
Dave Jones	GS-13-01	$37,599 x 40/2087 hours =	$720.63
Writing Test Report			
Jane Doe	GS12/01	$31,619 x 160/2087 hours =	$2424.07
			$7688.39
Overhead Costs		$ 7,688.39 x 1.29 =	$9918.02
TOTAL ESTIMATED TEST COSTS			$9918.02

Figure 3. Cost Estimate Equations of A Test Effort



NOTE: On C-5A only A1 thru A6 were used.

Figure 4. Typical FM Recording System.



SYMBOLS:
P Pallet with Honeywell 101 Recorder, Measurement Rack, Video Rack, and Power Converter
● C1 Camera 1 Looking at Left Gear
● C2 Camera 2 Looking at Nose Gear
● C3 Camera 3 Looking at Right Gear
◫ Accelerometer (1 axis) A1,A3,A12
☒ Accelerometer (2 axes) A4,A5 A6,A7 A8,A9 and A10,A11

NOTES:

FS 497	Service Outlet on Left Side of Aircraft 115VAC,400 Hertz,3 phase, 20 amps/phase
FS 428-500	Equipment on Type 463L pallet
FS 930	C.G. Accelerometer
FS 1020	Main Wheel Well Inspection Windows
FS 1045	Cyrogenic Plug Locations

Figure 5. Transducer Layout.

A.5 TABLE V DATA TAPE RECORDS ON C-5A(TN 690004)

(Page 1 of 2)
Recorder Type: Honeywell 101 Tape Speed: 15/16 ips
Track 1-6: A1-A6 mbfm Track 14: Time Code-Direct Record Track 16: Voice

REC	FOOTAGE	DATE	TIME	REMARKS
1	2000-2011	10/11	1446-1448	A2 +1g, 0g, -1g Cal
2	2011-2022		1448-1450	A4 +1g, 0g, -1g Cal
3	2022-2033		1451-1453	A6 +1g, 0g, -1g Cal
4	2033-2044		1501-1503	A1 +1g, 0g, -1g Cal
5	2044-2055		1504-1506	A3 +1g, 0g, -1g Cal
6	2055-2067		1507-1509	A5 +1g, 0g, -1g Cal
7	2067-2093		1615-1621	Oscillograph Setup Record
8	2093-2108		1727-1730	Shunt Cal
9	2108-2117	10/13	1420-1422	Shunt Cal
10	2117-2125	10/15	1103-1105	Shunt Cal
11	2125-2285		1224-1258	Takeoff Mildenhall/ Landing Wethersfield
12	2279-2290		1359-1401	(1A) 5 Knot Back Taxi
13	2290-2297		1405-1406	(2) 10 Knot Taxi
14	2297-2303		1423-1425	(2A) 5 Knot Back Taxi
15	2308-2313		1428-1429	(3) 20 Knot Taxi
16	2313-2328		1445-1449	(3A) 5 Knot Back Taxi
17	2328-2334		1451-1452	(4) 20 Knot Braking
18	2334-2347		1509-1512	(4A) 5 Knot Back Taxi
19	2347-2354		1515-1516	(5) 40 Knot Acceleration
20	2354-2363		1535-1537	(5A) 5 Knot Back Taxi
21	2363-2372		1538-1540	(6) 40 Knot Braking
22	2372-2380		1556-1558	(6A) 5 Knot Back Taxi
23	2380-2387		1559-1601	(7) 60 Knot Acceleration
24	2387-2394		1620-16212	(7A) 5 Knot Back Taxi
25	2394-2398		1630-1631	60 Knot Braking
26	2398-2571		1743-1820	Takeoff Wethersfield/Landing Mildenhall
27	2571-2518		1822-1824	Shunt Cal
28	2578-2580		1824-1826	Shunt Cal
29	2580-2590	10/16	1123-1125	Shunt Cal

TRACK ASSIGNMENTS AS OF 9/16/86

Tape Speed=7-1/2 ips for DC-5 Kilohertz

Track	Rec A	Rec B	RecC
1	A1	K3	K5
2	A2	K4	K7
3	K2	K17	K8
4	K1	K18	K10
5	K9	K24	K11
6	K6	K25	K13
7	K19	K26	K14
8	K12	K27	K16
9	K20	bad	K21
10	K15	K29	K22
11	K32	K30	K23
12	K33	K31	K28
13	pam	pam	pam
14	Irig-B	Irig-B	Irig-B
15/16	Voice	Voice	Voice

Figure 6. Typical Test Tape Log And Transducer Location.

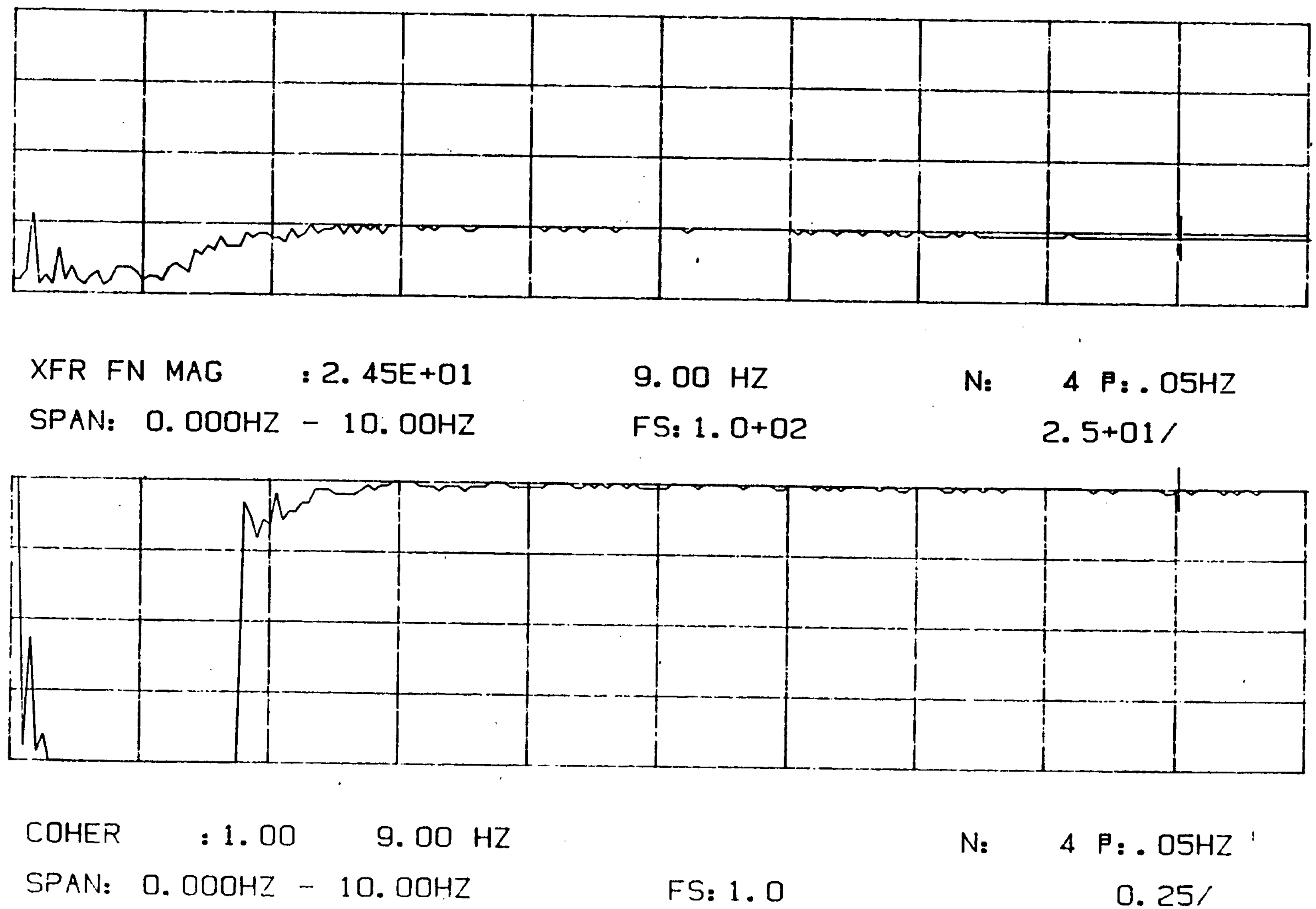


Figure 7. Sample Report Ready Plots From Spectrum Analyzer.

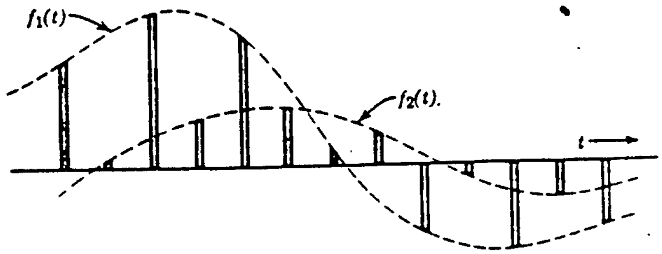


Figure 5.11 Time multiplexing of two signals.

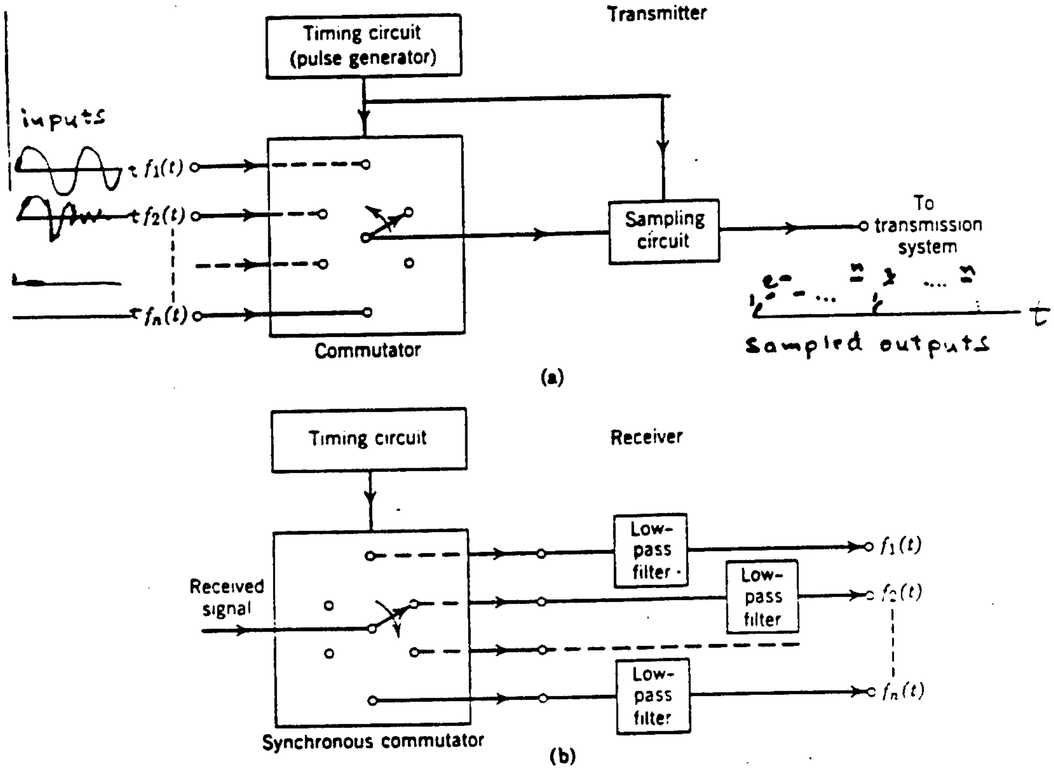


Figure 5.12 Time multiplexing of *n* channels.

TIME DIVISION MULTIPLEXING - MIL-STD Definition

Sample Hold	Not Sample and Hold
t_{11}	t_{11}
t_{12}	t_{22}
t_{13}	t_{33}
t_{14}	t_{44}
t_{21}	t_{51}
t_{22}	t_{62}
t_{23}	t_{73}
t_{24}	t_{84}

Time Channel Number

Figure 8. Time Division Multiplexing.

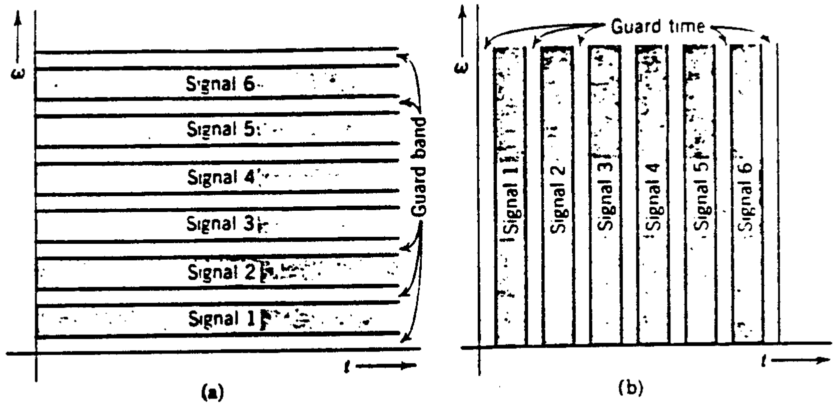


Figure 5.15 Communication space representation of frequency and time multiplexing.

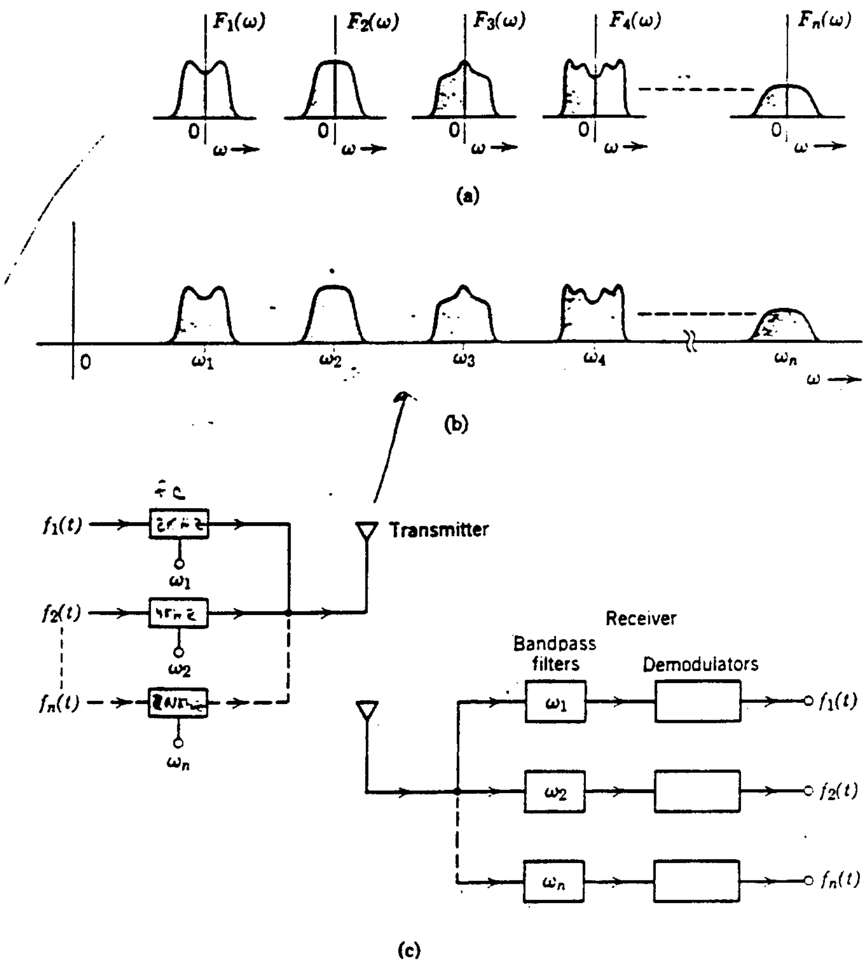


Figure 9. Frequency Division Multiplexing.

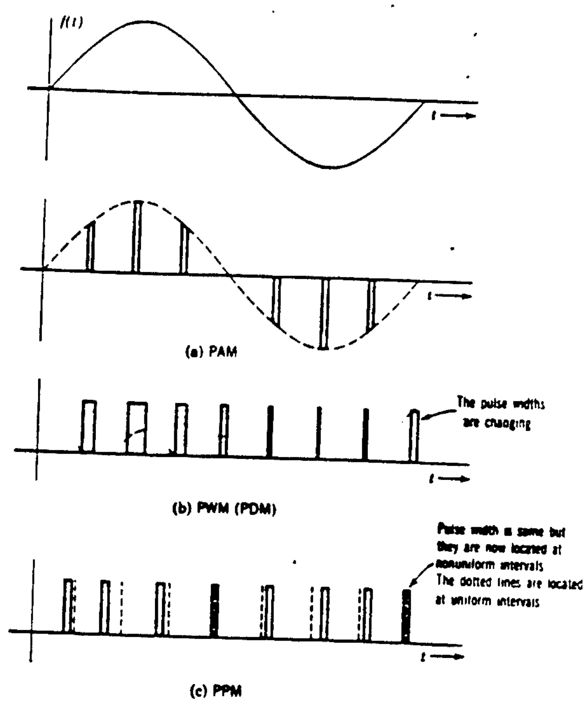
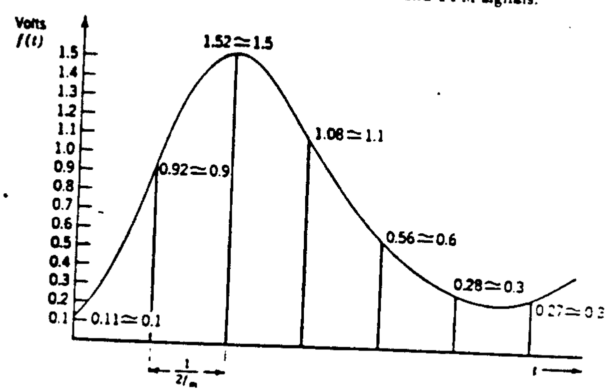


Figure 5.9 Representation of PAM, PWM, and PPM signals.



(a)

Digit	Binary equivalent	Pulse-code waveform
0	0000	
1	0001	
2	0010	
3	0011	
4	0100	
5	0101	
6	0110	
7	0111	
8	1000	
9	1001	
10	1010	
11	1011	
12	1100	
13	1101	
14	1110	
15	1111	

(b)

Figure 5.10 (b) A possible form of pulse code.

Figure 10. PCM Encoding.

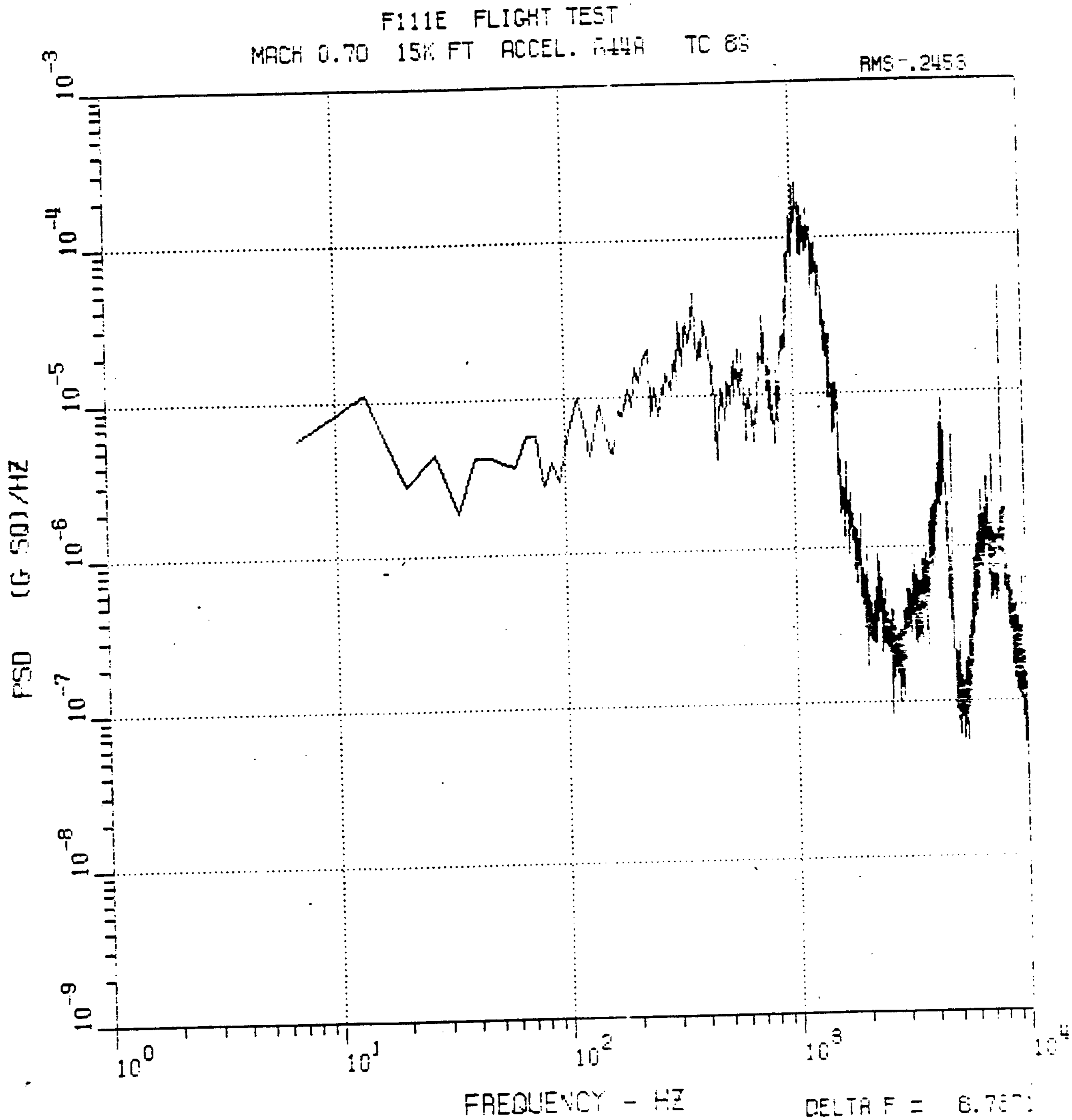


Figure 11. Single Channel Power Spectra Density(PSD) Plot.

F-15 RUN 54 KULITE 4 M1.2 EPR 2.0

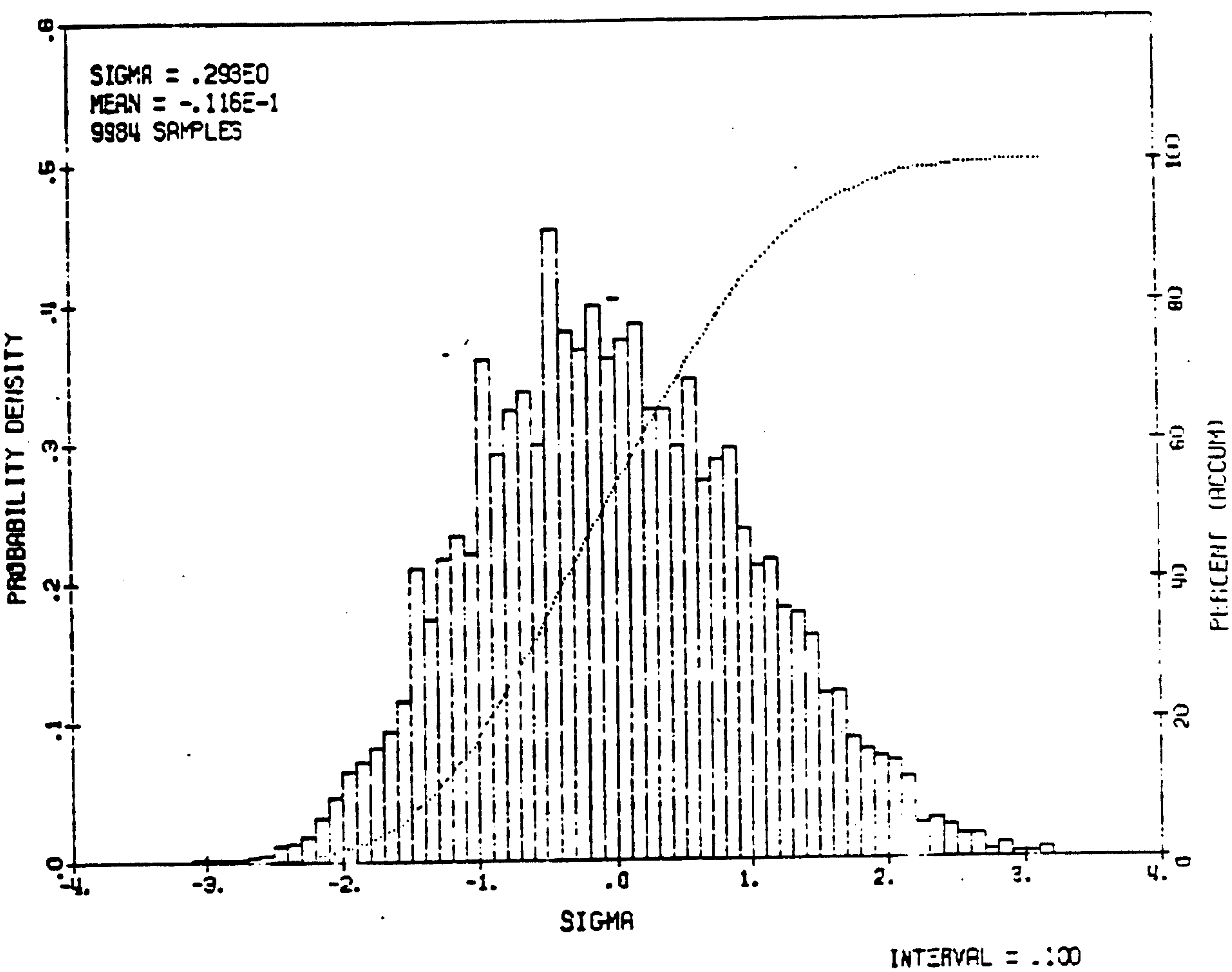


Figure 12. Single Channel Probability Density Function Plot.

PRELIMINARY DATA

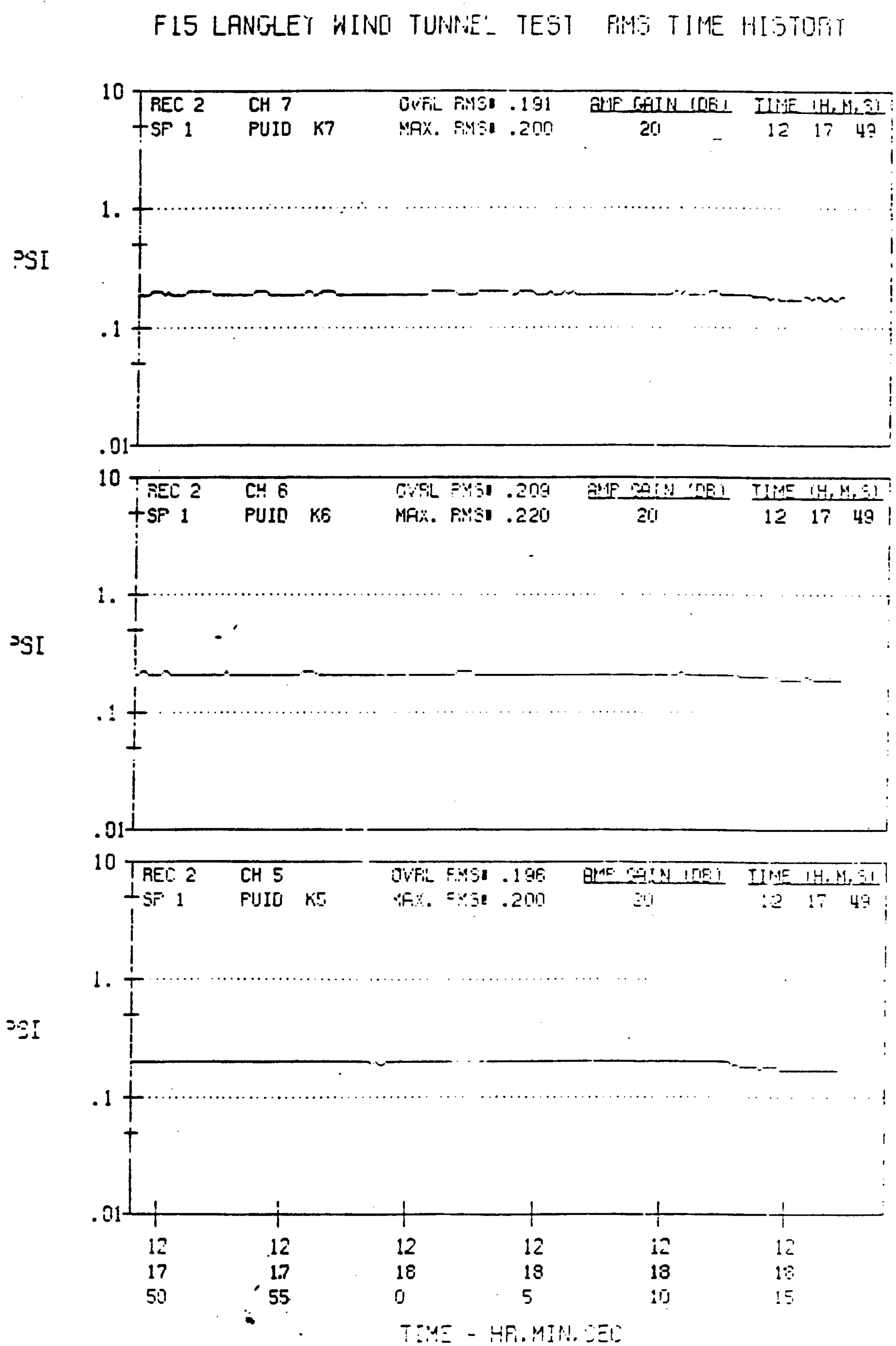


Figure 13. Single Channel RMS Time History Plots.

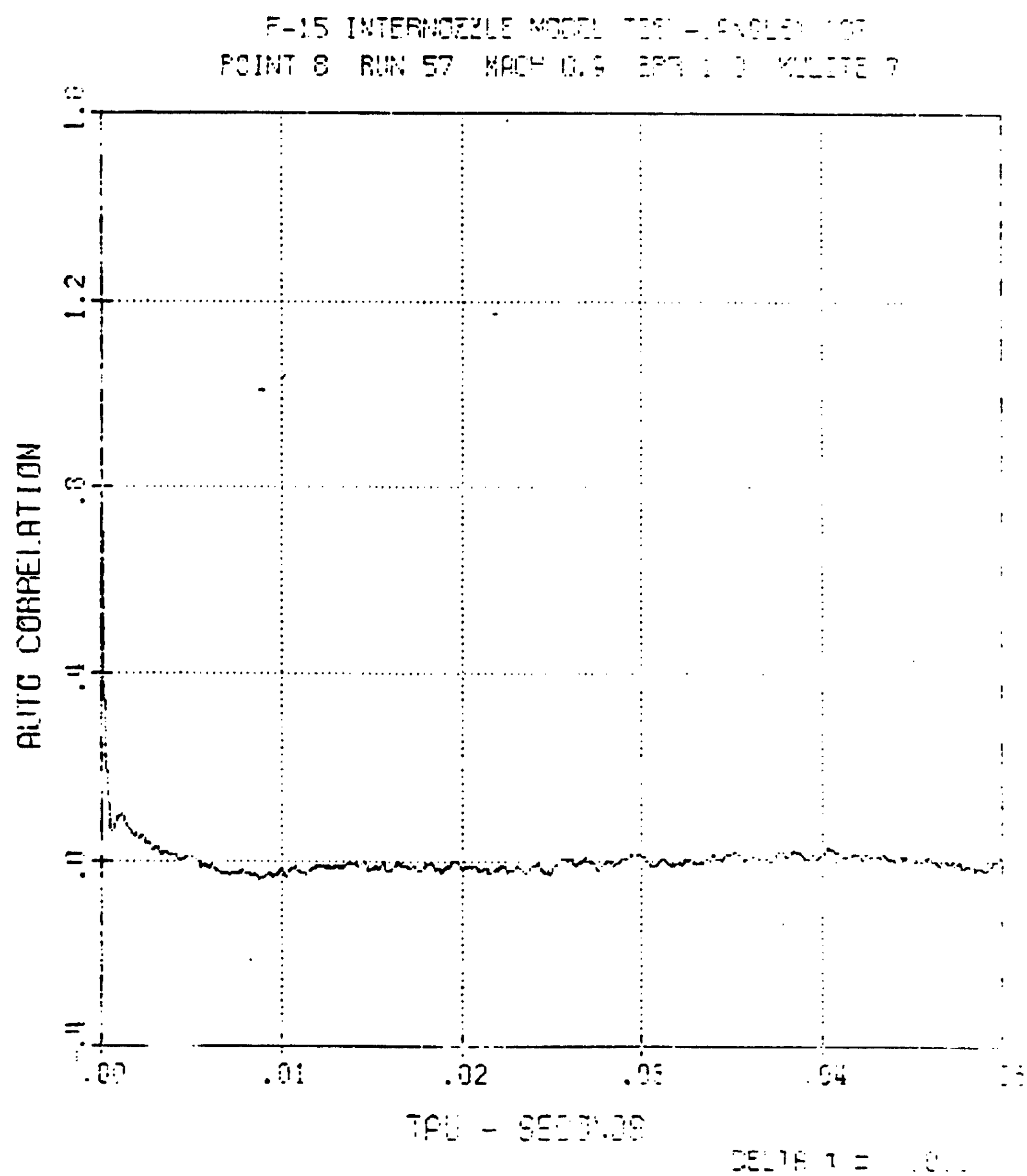


Figure 14. Single Channel Autocorrelation Function Plot.

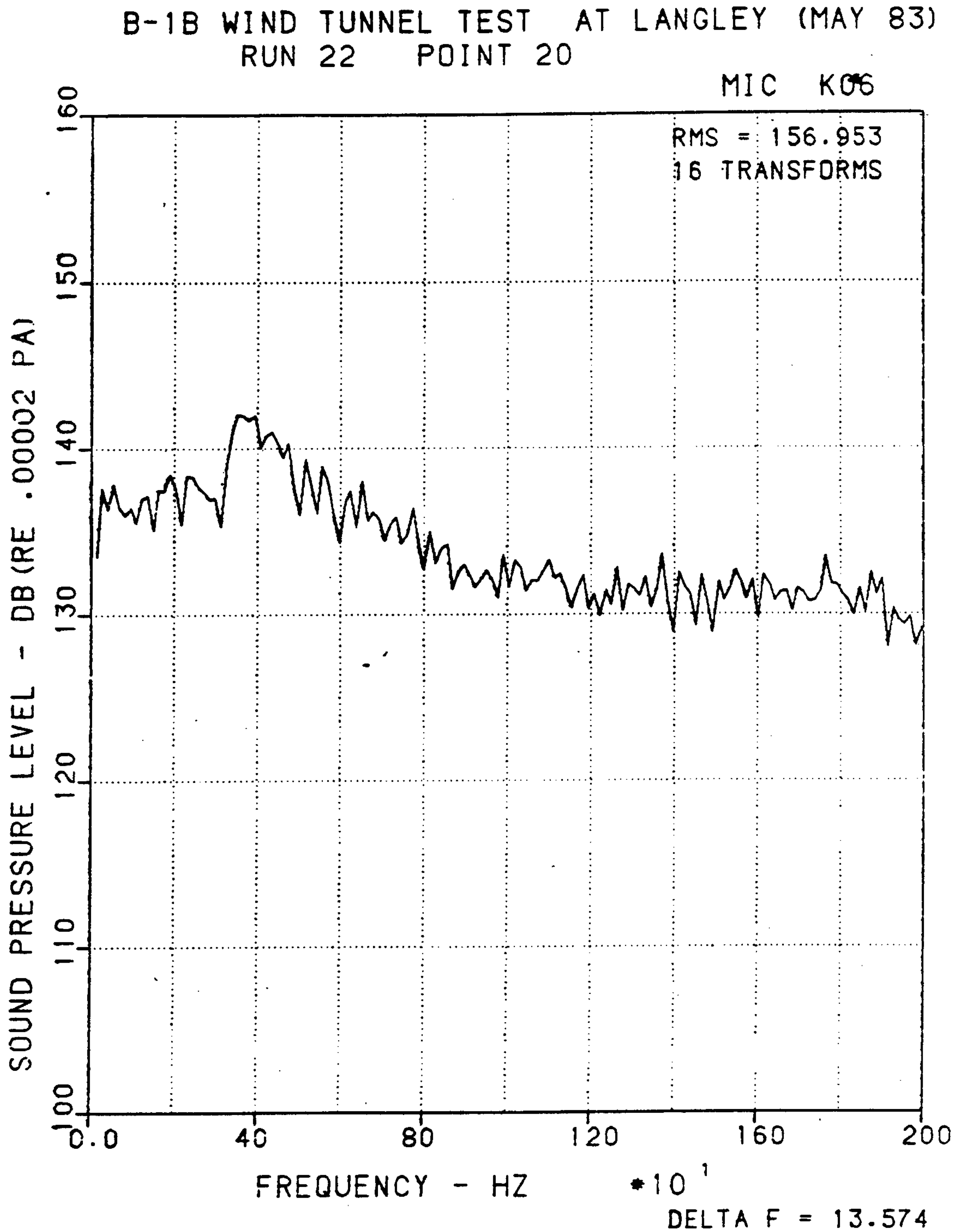
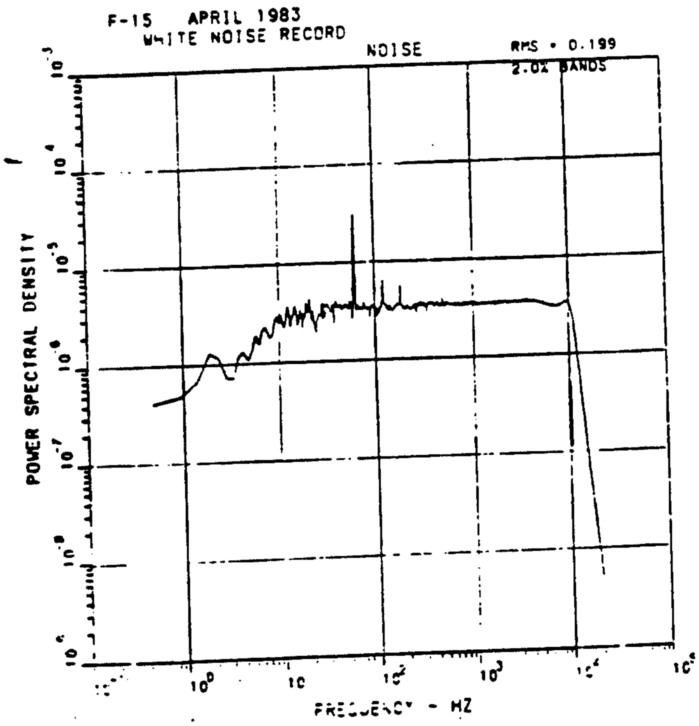
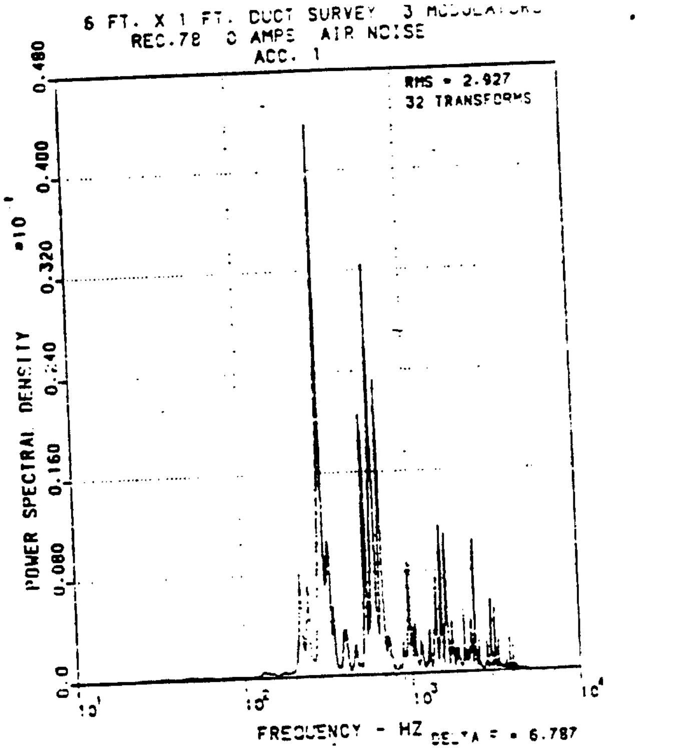


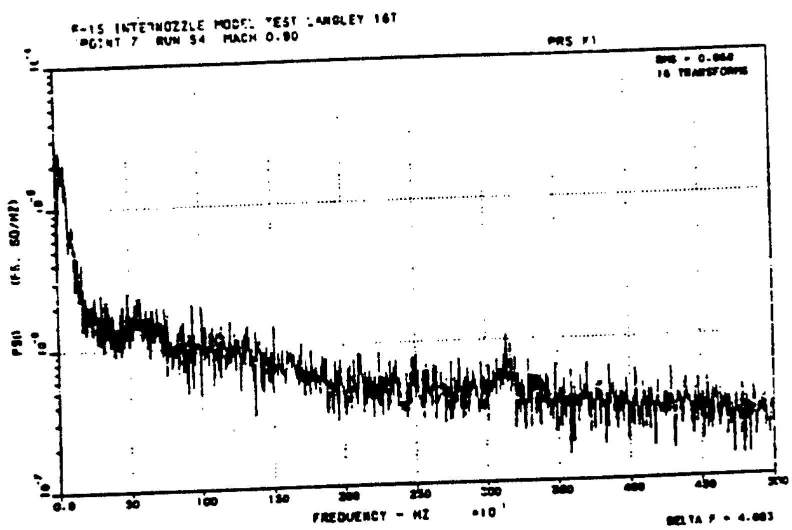
Figure 15. Single Channel Sound Pressure Level(SPL) Plot.



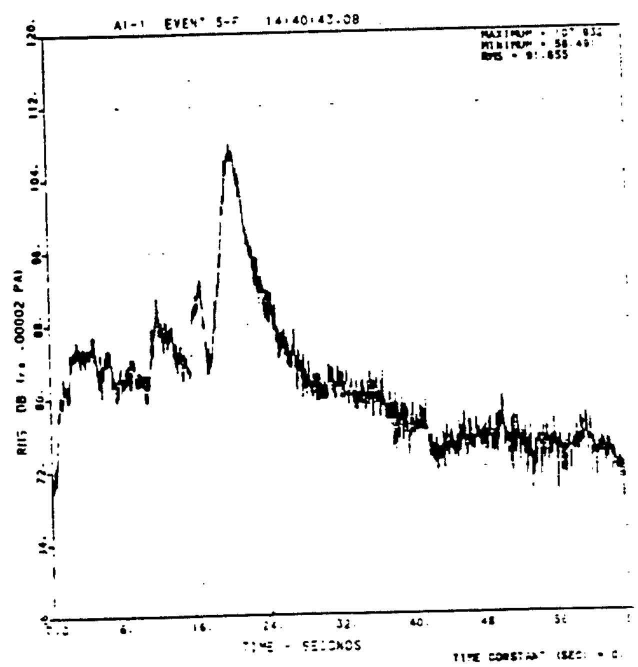
Log/Log



Log/Lin



LIN/LOG



LIN/LIN

Figure 16. Lin/Lin, Log/Log, Lin/Log And Log/Lin Plots.

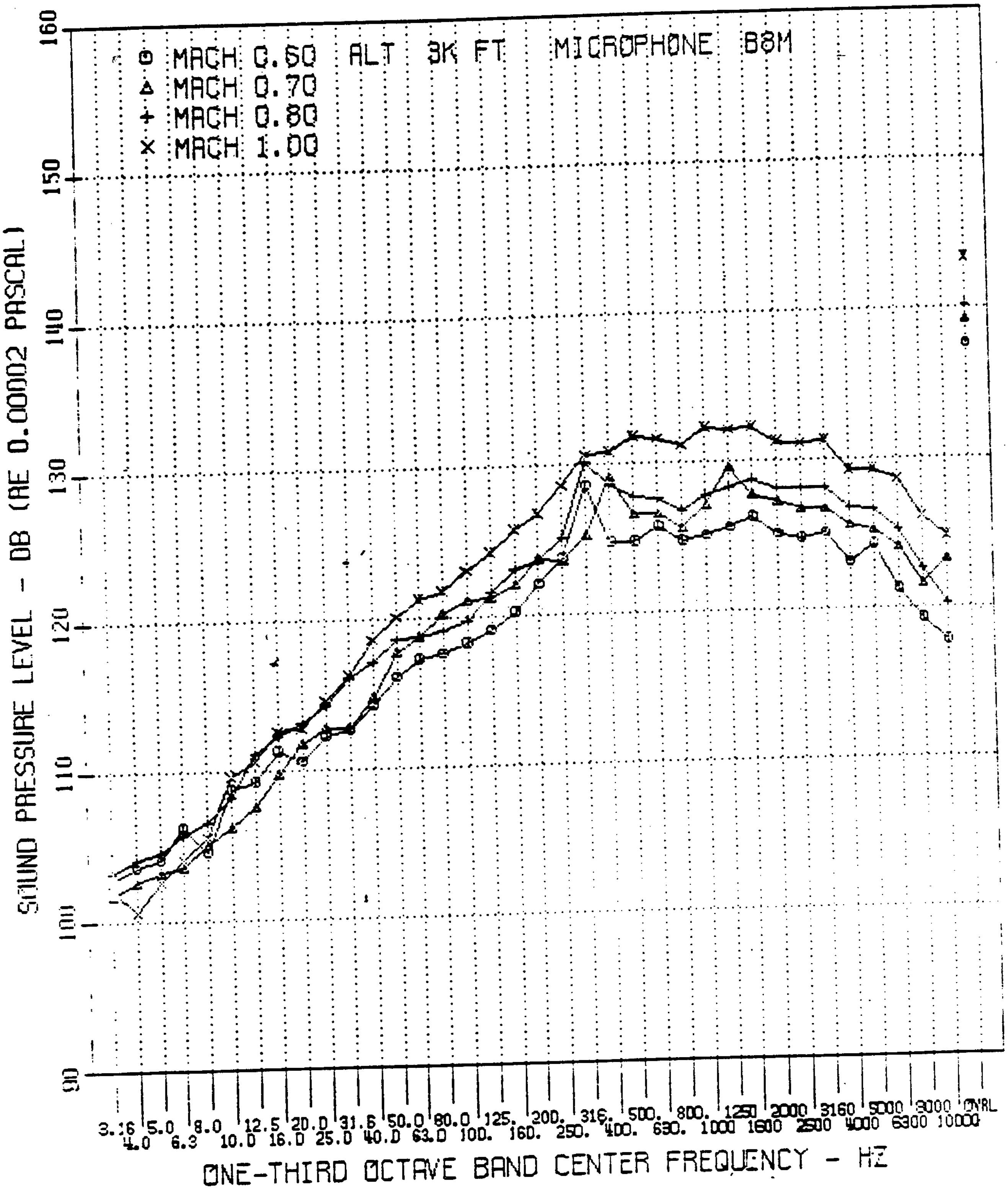


Figure 17. One-Third Octave Band Plot.

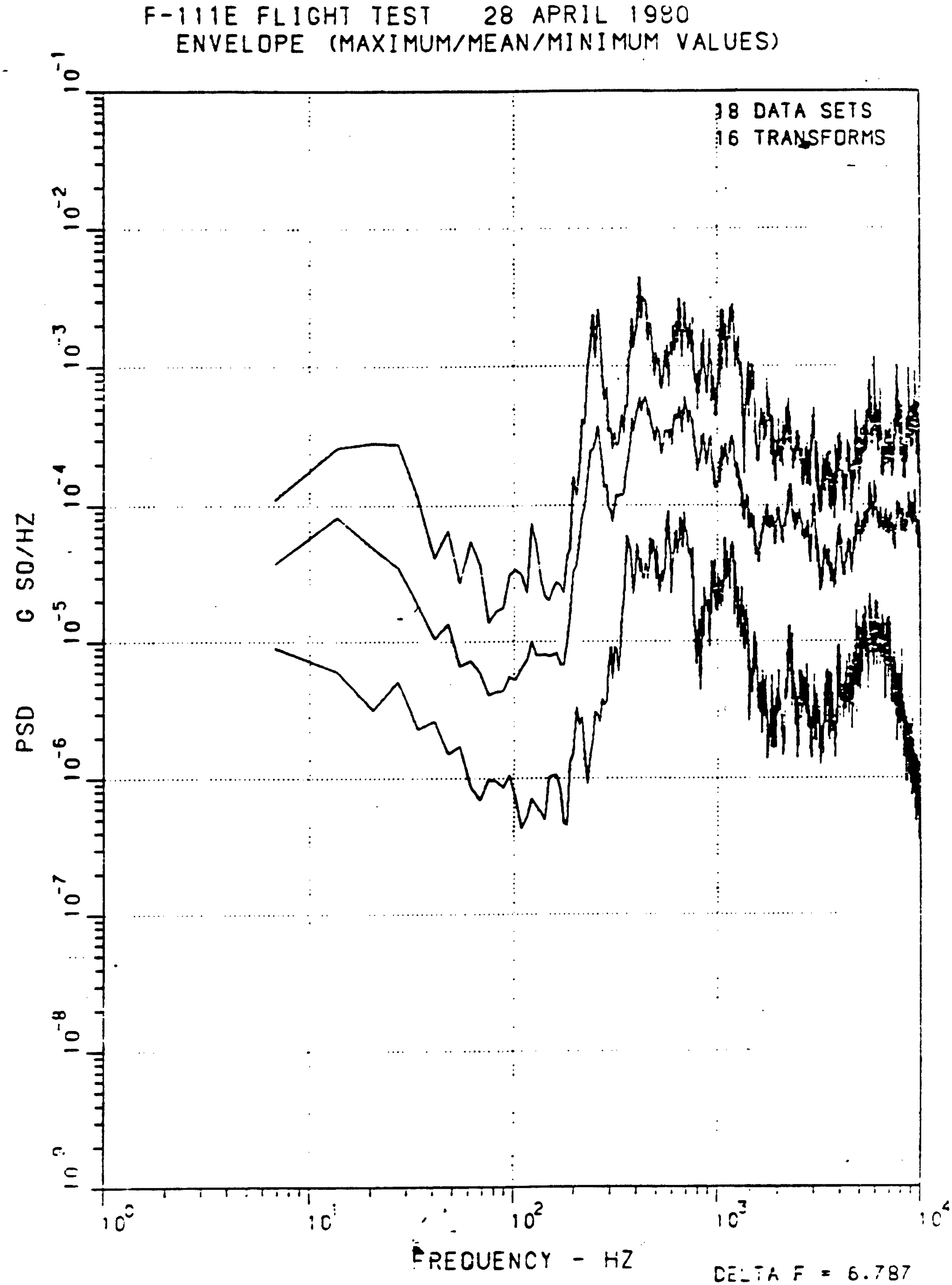


Figure 18. Envelop(Statistical) Plot.

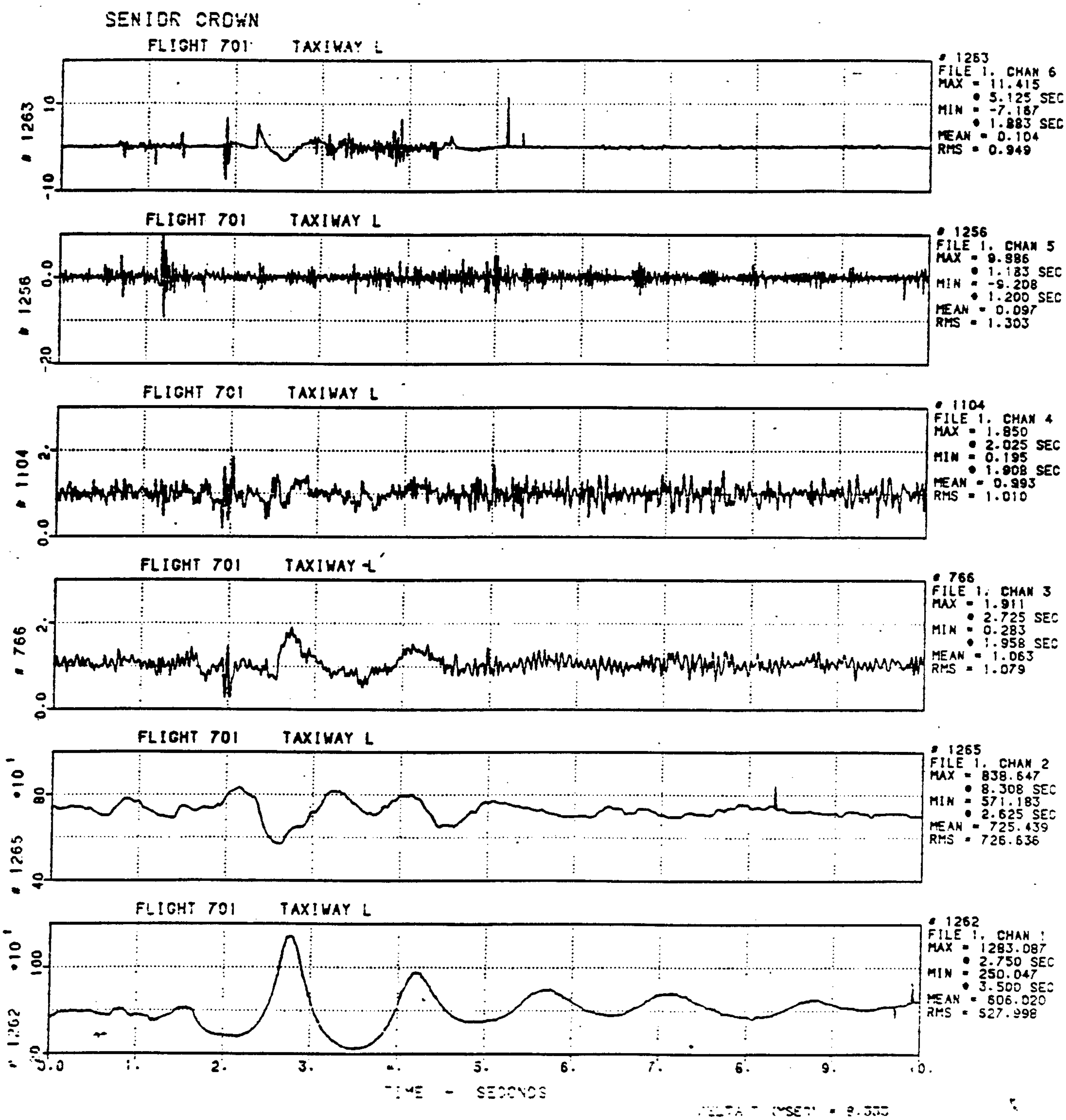
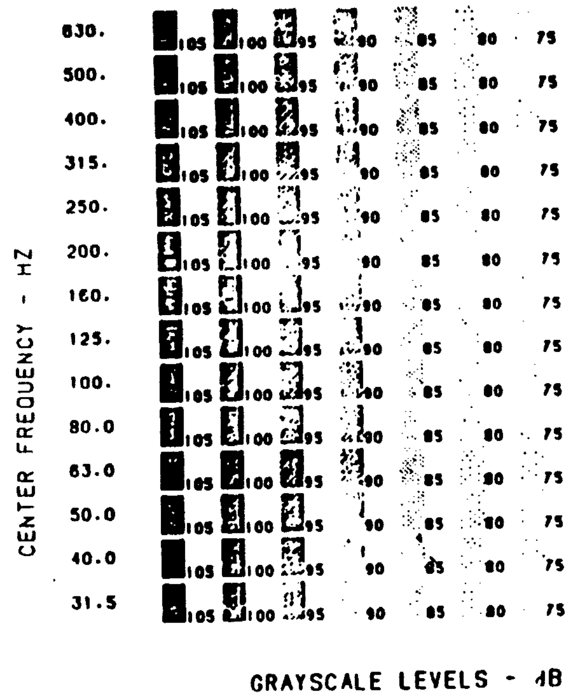
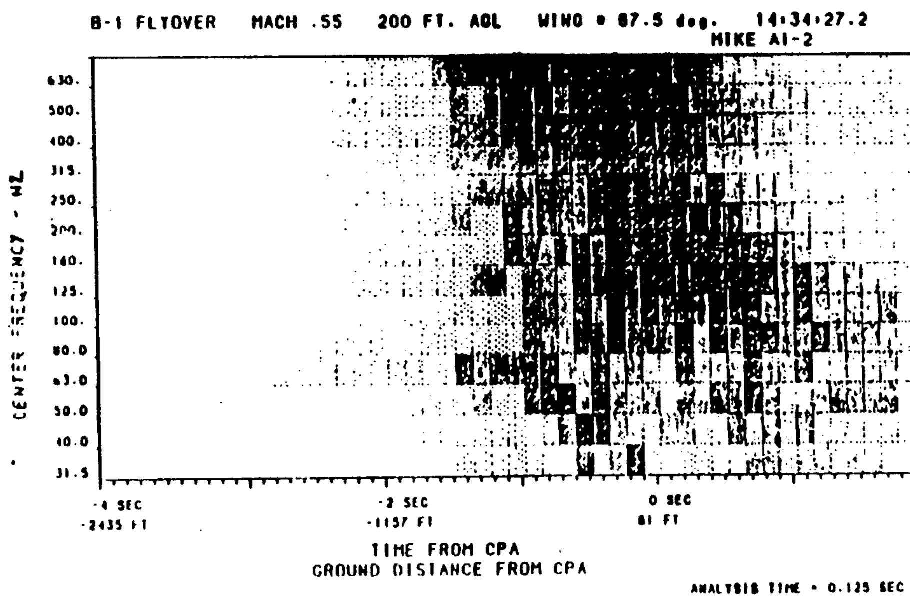


Figure 19. Multiple Channel Plots.





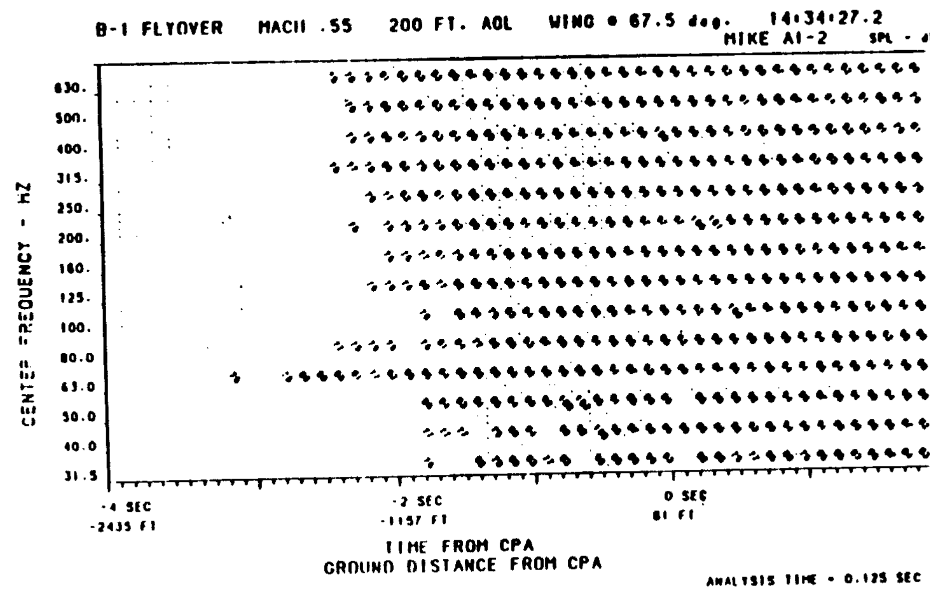
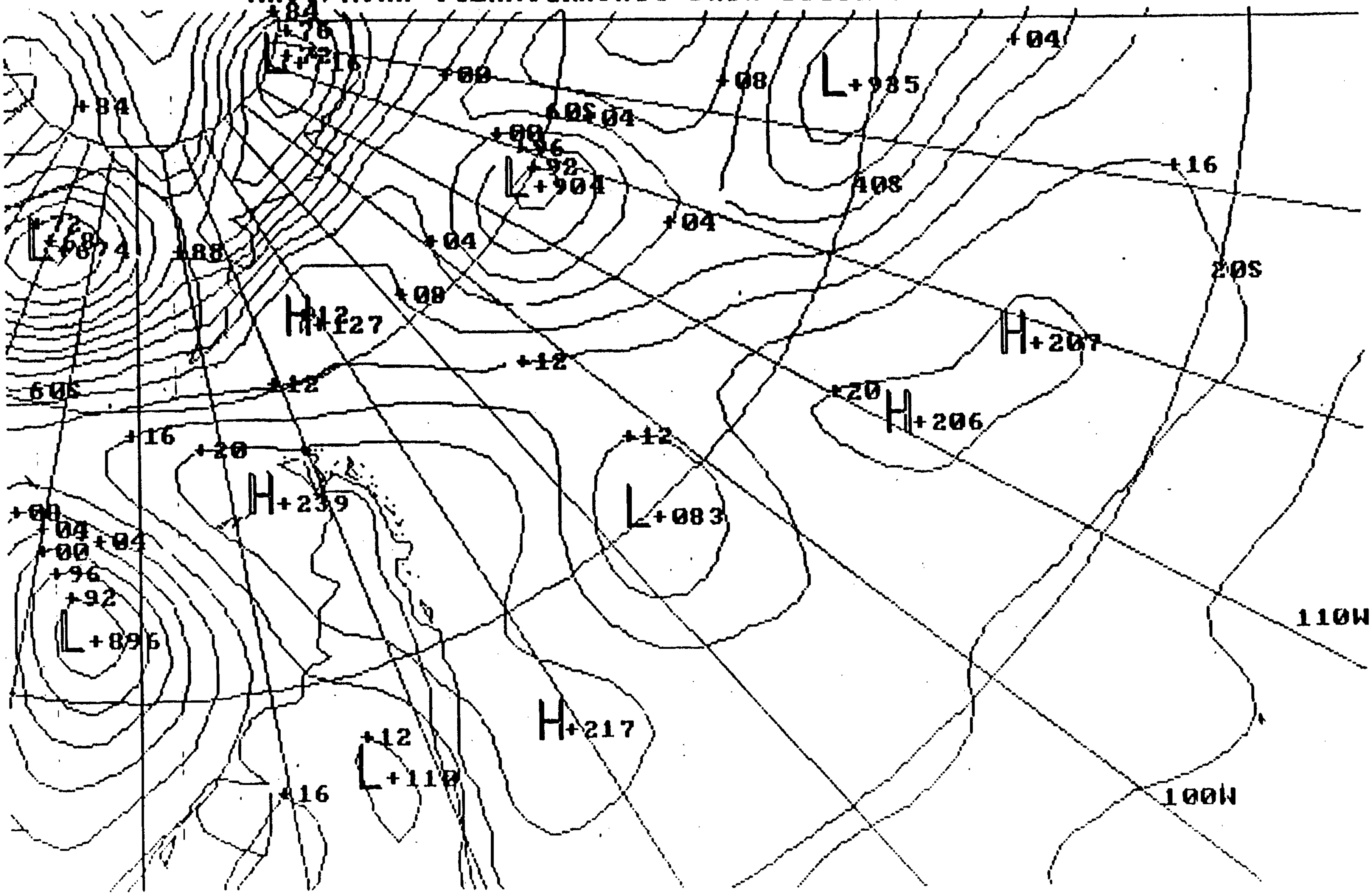


Figure 20a. Code For A Carpet Plot.

Figure 20b. Carpet Plot.

Figure 20c. Values For A Carpet Plot.

NAVY/NOAA OCEANOGRAPHIC DATA DISTRIBUTION SYSTEM



NOGAPS SFC PRES 24HR PROG VT 12Z 21 SEP 84

Figure 21. Contour Plot.

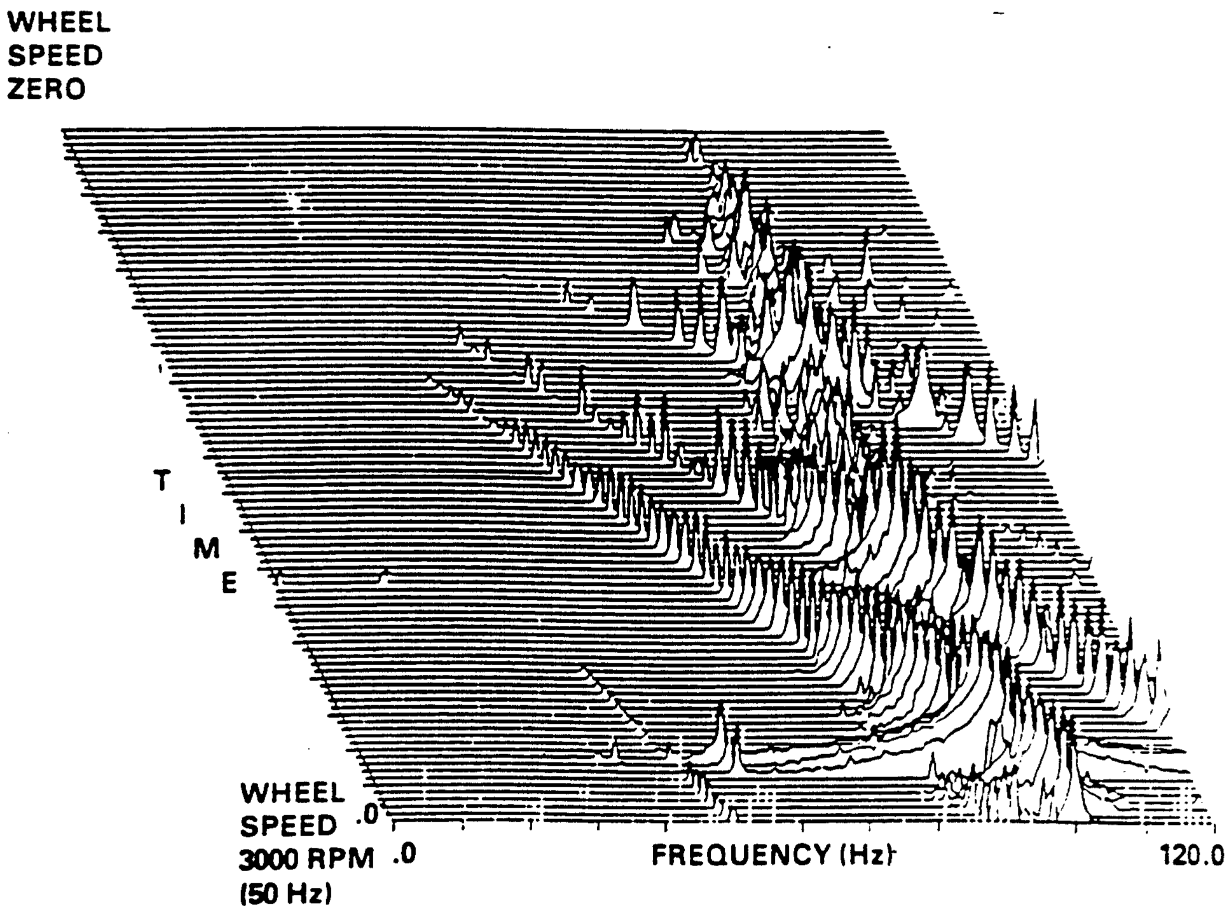


Figure 22. Waterfall Plot.

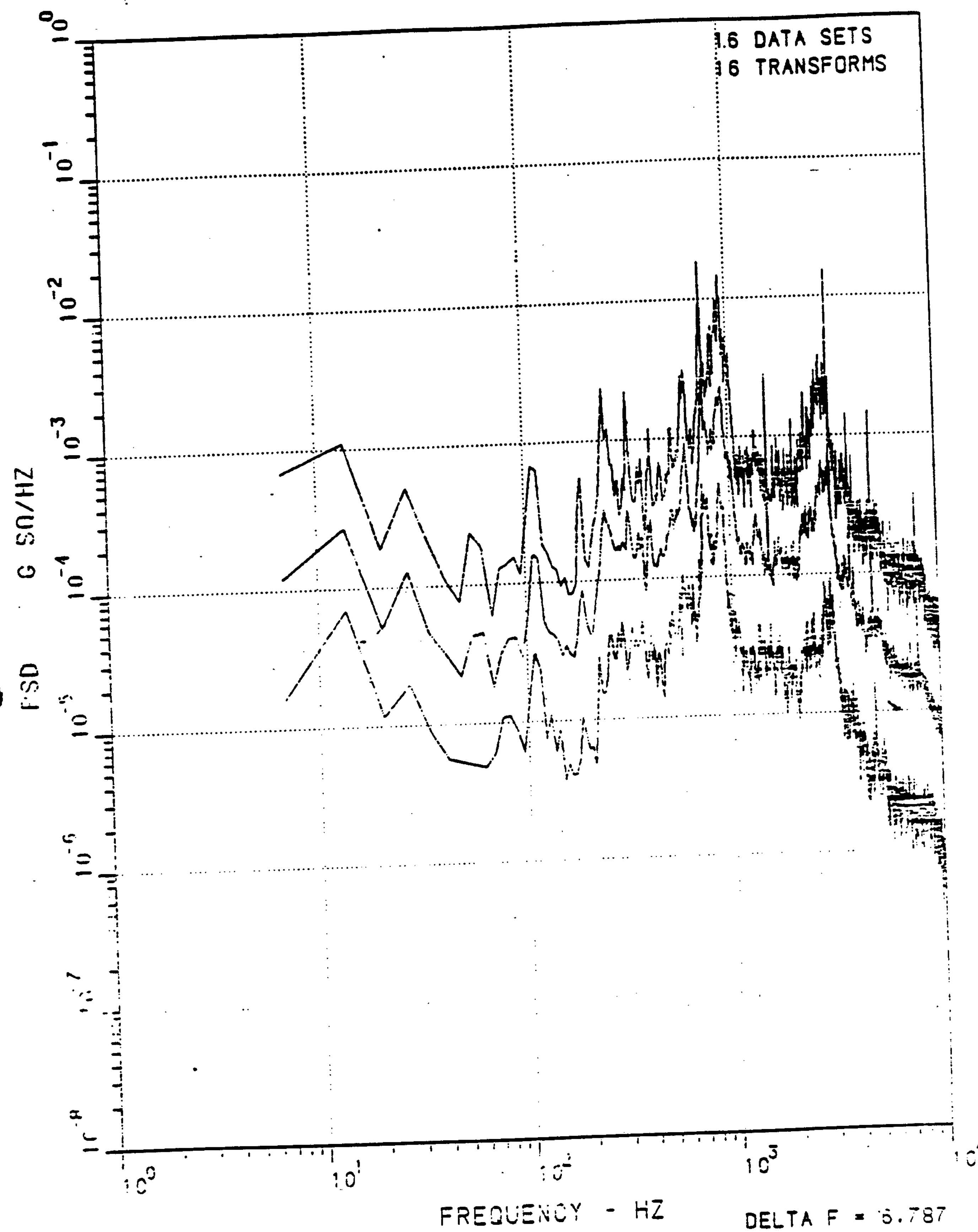


Figure 23. Statistical(Max,Mean,Min) Plot.

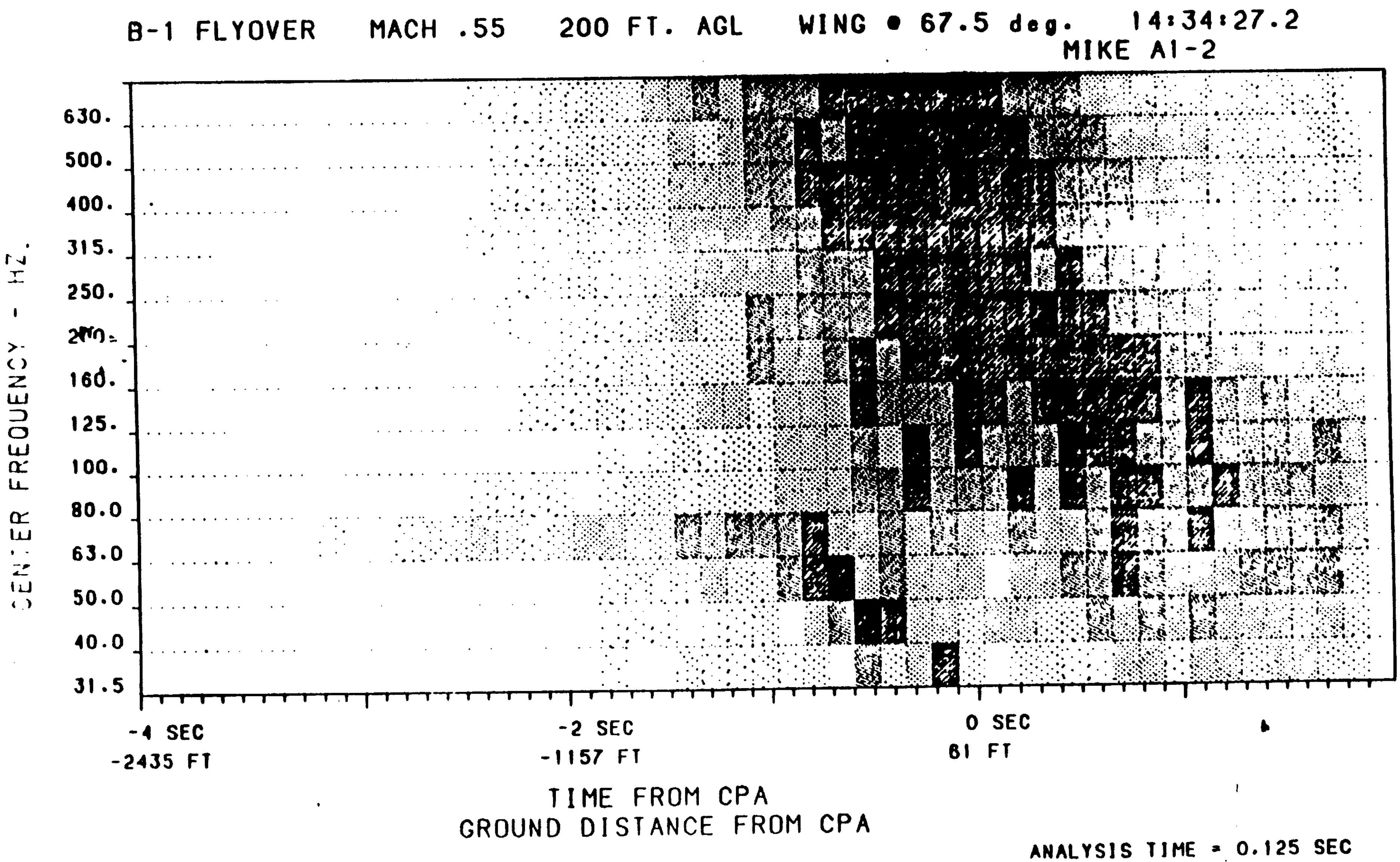


Figure 24. Acoustic Intensity Plot.

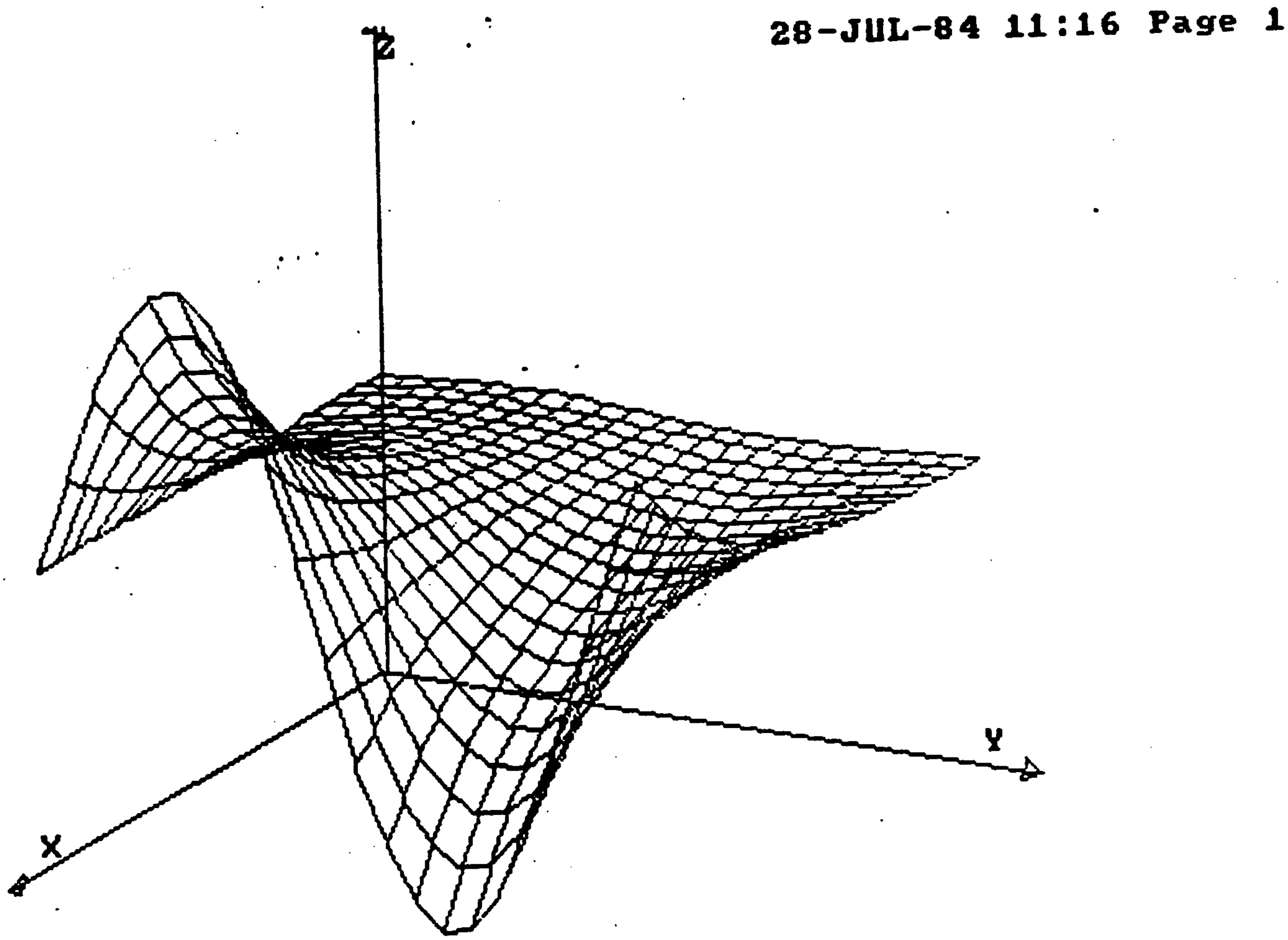
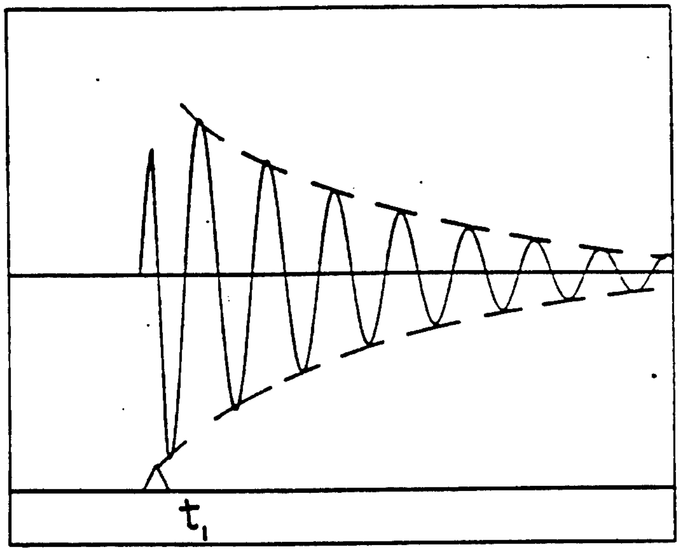


Figure 25. Three Dimensional Plot.

2. THE RESPONSE OF A ONE DEGREE-OF-FREEDOM OSCILLATOR TO A SINGLE DISTURBANCE

Assume a one degree-of-freedom oscillator, with damping less than the critical value, receives some excitation that stops at time $t = t_1$.



For times after t_1, when the response is decaying freely, the acceleration response can be written:

$$\ddot{x}(t)\Big|_{t>t_1} = e^{-\alpha\omega(t-t_1)}\left\{A_1 \sin\left[\omega(t-t_1)\right] + B_1 \cos\left[\omega(t-t_1)\right]\right\} \tag{2.1}$$

where:

t_1 = the time the excitation ends

ω = damped frequency

α = damping/ω

A_1, B_1 = Constants which depend on α, ω, the excitation and the initial conditions

The decaying acceleration response also can be written as:

$$\ddot{x}(t)\Big|_{t>t_1} = R_1 e^{-\alpha\omega(t-t_1)} \sin\left[\omega(t-t_1) + \phi_1\right] \tag{2.2}$$

where:

$$R_1 = \sqrt{A_1^2 + B_1^2}$$
$$\sin\phi_1 = B_1/R_1$$
$$\cos\phi_1 = A_1/R_1$$

We loosely refer to R_1 as the potential amplitude of the acceleration response. However, for positive damping, the instantaneous value of the acceleration response will never reach the value of R_1 because of the term $e^{-\alpha\omega(t-t_1)}$ in Equations (2.1) and (2.2). Further, a subsequent disturbance could interrupt the acceleration response to amplify or attenuate it. R_1 is then an upper bound on the amplitude of the acceleration response to a single disturbance.

For small damping ($\alpha << 1$) the behavior of the acceleration response will be dominated by the term $\sin\left[\omega(t-t_1) + \phi_1\right]$ in Equation (2.2), so we would expect its local maxima and minima to be obtained from solutions of

$$\cos\left[\omega(t-t_1) + \phi_1\right] \approx 0$$

Figure 26. Sample Typeset Report Page With Equations.

(SAMPLE)

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This technical report has been reviewed and is approved for publication.

JANICE M. CHINN
Project Engineer

JEROME PEARSON, Chief
Structural Vibration & Acoustics Branch

FOR THE COMMANDER:

"If your address has changed, if you wish to be removed from our mailing list, or if the addressee is no longer employed by your organization please notify AFWAL/FIBG, W-P AFB, OH 45433 to help maintain a current mailing list".

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Figure 27. Notice Page For A Technical Report.

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(SAMPLE)

REPORT DOCUMENTATION PAGE					
1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS			
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT			
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) Contractor No. 001		5. MONITORING ORGANIZATION REPORT NUMBER(S) AFWAL-TR-87-3052			
6a. NAME OF PERFORMING ORGANIZATION Contractor's Name	6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Structural Vibration & Acoustics Br			
6c. ADDRESS (City, State and ZIP Code) Contractor's Street Address Contractor's City, State & Zip Code		7b. ADDRESS (City, State and ZIP Code) AFWAL/FIBG WPAFB, OH 45433-6553			
8a. NAME OF FUNDING/SPONSORING ORGANIZATION (Funding Organization)	8b. OFFICE SYMBOL (If applicable) AFWAL/FUND	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER			
8c. ADDRESS (City, State and ZIP Code) Funding Organization Street Address) City, State and Zip Code		10. SOURCE OF FUNDING NOS			
		PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.
11. TITLE (Include Security Classification) Report Title		62201F	87	2401	02-12
12. PERSONAL AUTHOR(S) Author No. 1, Author No. 2, Author No. 3, and Author No. 4					
13a. TYPE OF REPORT Final	13b. TIME COVERED FROM Oct 86 TO Jul 87	14. DATE OF REPORT (Yr., Mo., Day) August 1987		15. PAGE COUNT 225	
16. SUPPLEMENTARY NOTATION None					

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB. GR.	Structural Analysis; Computer Programs; Vibration Test; Information Retrieval

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report describes the operation and activities of the (Contractor's Name) from October 1, 1986 through August 31, 1987. (Contractor's Name) is operated for the Flight Dynamics Laboratory by (Performing Organization). The objective of the (Organization) is to collect, evaluate, store and disseminate information about vibration and acoustics. As part of this service, (Organization's Name) distributes structural analysis computer codes, research findings and their documentation. In addition, an analysis capability is maintained for solving structural and testing problems as authorized by the Flight Dynamics Laboratory, AFWAL. During the reporting period, (Performing Organization) performed one thousand research efforts for its customers. The major tests include flight data on the F-16 and F-15

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Figure 28. Report Documentation Page.

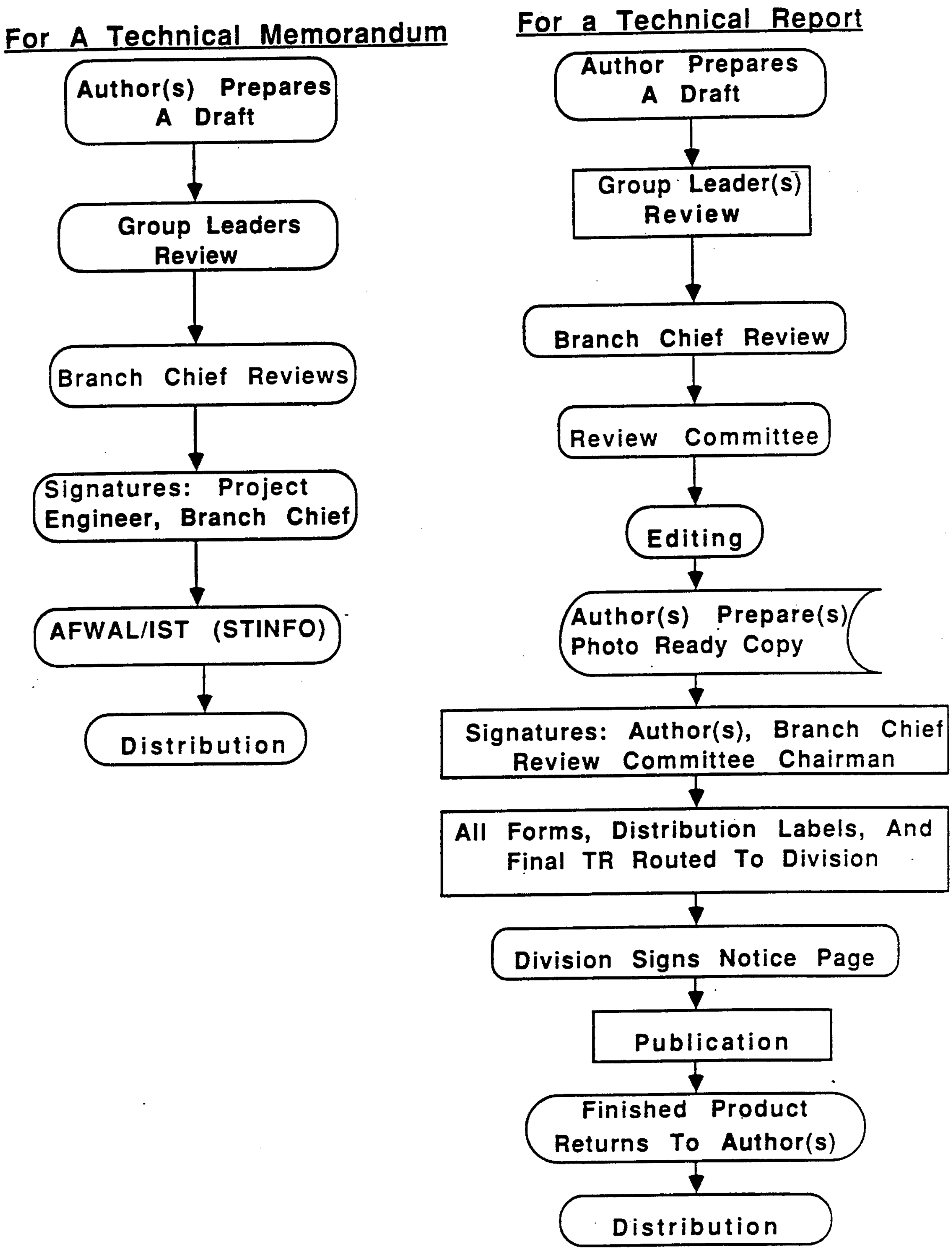

Figure 29. Chain of Command Flow Chart

REQUEST FOR EDITORIAL REVIEW OF DRAFT TECHNICAL REPORT		DATE Today's Date
TO: STINFO	TO: EDITING	TO: RPT PREPARATION
1 CONTRACT NO /INTERNAL F33615-87-C-3012	2 PROGRAM ELEMENT 62201F	3 PROJECT TASK WORK UNIT 24010233
4 GOV'T AUTHOR MONITOR Primary Author's Name	5 SYMBOL AFWAL/FIBG	6 PHONE (513) 255-1234

7 TYPE REPORT	8 TYPES OF REVIEW	9 CLASSIFICATION
☐ I (Interim) ☒ F (Final)	☒ COMPLETE ☐ CURSORY ☐ TR NO ONLY (Send to ☐ DITC Only ☐ Printing)	☒ U (Unclassified) ☐ C (Confidential) ☐ S Secret

10.a TITLE

(Title of the report)

b SUB TITLE

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22 THE FOLLOWING APPLIES TO YOUR REPORT	23 TRF ACCESSION NO
TR NUMBER DATE TR WILL BE RETURNED TO REQUESTER (Includes time in editing and time in * production * Production applies to in-house report only)	24 REMARKS

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Figure 30. Request For Editorial Review and Report Number.

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WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6523

REPLY TO ATTN OF:

SUBJECT: Request for Public Release Approval (AFR/ASDR 190-1)

TO: AFWAL/GLIST
ASD/PA
IN TURN

1. Please review the attached material for public release approval. The following information is provided in support of this request:

a. Type of information (abstract, journal article, presentation, film/script, technical report, etc.): Journal Article

b. Title: (Title of the Article)

c. Author(s) name, title, & organization: ______

d. Contract #/Company name: ______ Contract (1) contains DD Form 254: ( ) Yes (x) No - (2) refers to a Security Classification Guide: ( ) Yes (x) No

e. To be published by (name/address of publisher): ______

f. To be presented at (give sponsoring organization or technical society, location (city/state), and exact date of presentation): ______

g. Deadline for submittal (if other than presentation date): ______

2. The reverse side of this letter has been completed. (Requester must complete and sign reverse side.)

3. The information contained in this material is unclassified, technically accurate, nonproprietary, and considered suitable for public release. It contains no computer software owned or developed by or for the government. Export restrictions (i.e., MCTL, Munitions List (ITAR), and CCL) and current AF/DOD policy have been considered prior to requesting public release approval.

ASD/PA APPROVAL ______

FOR THE COMMANDER

______
(Division level/equivalent signature and title)

Figure 31. Form Letter Of Request For Clearance And Public Release.
(AFWAL Form 143a)

REQUEST FOR EDITORIAL REVIEW OF DRAFT TECHNICAL REPORT		DATE
TO: STINFO	TO: EDITING	TO: RPT PREPARATION
1 CONTRACT NO./INTERNAL F33615-87-C-1234	2 PROGRAM ELEMENT 62201F	3 PROJECT/TASK WORK UNIT 24010657
4 GOV'T AUTHOR MONITOR Primary Author's Name	5 SYMBOL AFWAL/FIBG	6 PHONE (513) 255-9876

7 TYPE REPORT	8 TYPES OF REVIEW	9 CLASSIFICATION
☐ I (Interim) ☒ F (Final)	☒ COMPLETE ☐ CURSORY ☐ TR NO ONLY (Send to ☐ DITC Only ☐ Printing)	☒ U (Unclassified) ☐ C (Confidential) ☐ S (Secret)

10 a TITLE

(TITLE OF THE REPORT)

b SUB TITLE

11. DISTRIBUTION STATEMENT (Circle One) (A B C D E F X 1 or N) (See reverse for explanation) A	12 DATE DRAFT REPORT RECEIVED FROM CONTRACTOR

13 CONTRACTOR

THE 1-2-3 COMPANY

14 DISTRIBUTION LIST TITLE (If Applicable) (Insert distribution names if possible or attach a distribution list)	CHECK ONE	
	YES	NO
15 COMPLETED DD FORM 1473 REPORT DOCUMENTATION PAGE, INCLUDED (Mandatory)	X	
16 REPORT CONTAINS COMPUTER SOFTWARE	X	
17 LABORATORY DIRECTORS FUNDS USED	X	
18 DTIC IS AUTHORIZED COPIES OF THIS REPORT (If not authorized state reason)	X	
19 REPORT CONTAINS EXPORT-CONTROLLED INFORMATION		X
20.a REPORT CONTAINS ☐ LIMITED RIGHTS ☐ PROPRIETARY INFORMATION		X
b IF YES, HAS THE LIMITATION BEEN APPROVED BY CONTRACTING OFFICER	N / A	

21 SUPERVISOR'S SIGNATURE TITLE

REMAINDER TO BE FILLED OUT BY STINFO

22 THE FOLLOWING APPLIES TO YOUR REPORT TR NUMBER DATE TR WILL BE RETURNED TO REQUESTER (Includes time in editing and time in * production) (* Production applies to in-house reports only)	23 TR ACCESSION NO 24 REMARKS

AFSC Form 2649, APR 87 PREVIOUS EDITION WILL BE USED

Figure 32. Request for Editing

TECHNICAL REVIEW OF AFWAL IN-HOUSE REPORT
_______________ DIVISION

Sec. 1 (Author): SUBMISSION OF DRAFT AFWAL TR _______________

Author _______________ Symbol _______ Extension _______

Document Form: ( ) Paper ( ) to be presented _______________

( ) to be published _______________

( ) Technical Report ( ) Other _______________

Classification _______ Applicable Distribution Statement _______

Draft Submitted _______________ _______________
(Author's Signature) (date)

Approved for Submission _______________ _______________
(Branch Chief) (date)

Sec. 2 (Division Chief): APPOINTMENT OF TECHNICAL REVIEW COMMITTEE

	Symbol:	Phone:	Date Appointed:
TRC Chairman _______________	_______	_______	_______
Member _______________	_______	_______	_______
Member _______________	_______	_______	_______

Sec. 3 (TRC Chairman): REVIEW

	Date Scheduled:	Accomplished:
Initial Group Meeting of TRC	_______	_______
Completion of Review (Meet with Author)	_______	_______
Letter Summarizing Action (Attach Copy)	_______	_______

Sec. 4 (Author): FINAL DRAFT

Date prepared: _______

Approved: "I find this manuscript technically acceptable and essentially ready for publication."

_______________ _______
(Branch Chief) (date)

_______________ _______ _______________ _______
(TRC Chairman) (date) (Division Chief) (date)

Approved Final Draft to TST-FI _______
To ASD/PA for clearance (Statement A Documents Only) _______
To AFWAL/TST for Editing _______
(date)

Figure 33. Review Committee Signature Form.

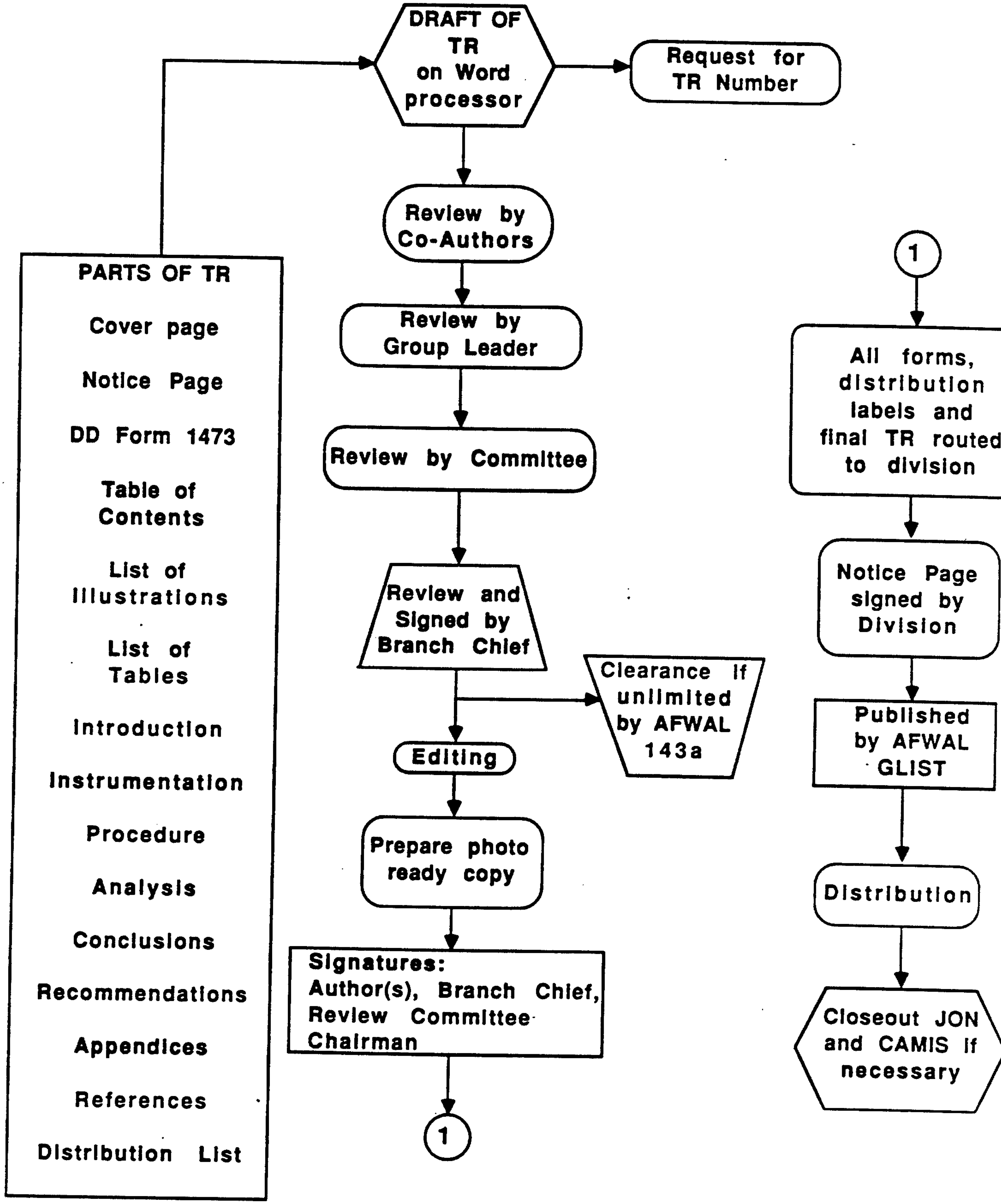


Figure 34. Procedures For Writing A Technical Report.

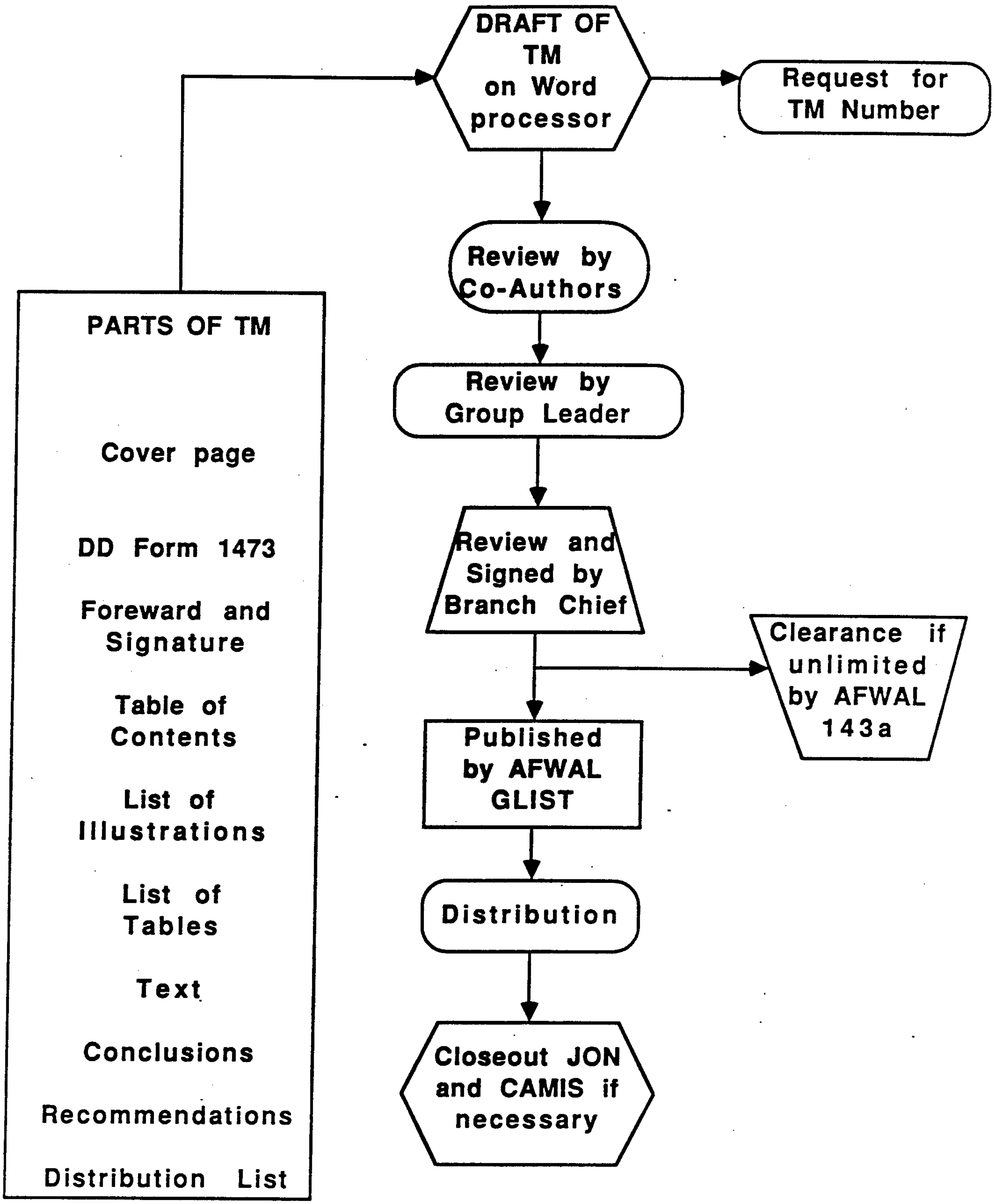


Figure 35. Procedures For Writing A Technical Memorandum.

DEPARTMENT OF THE AIR FORCE
AFHRL, LOGISTICS AND HUMAN FACTORS DIVISION (AFSC)
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433-6503

REPLY TO
ATTN OF:

SUBJECT: Request for Public Release Approval (AFR/ASDR 190-1)

TO: CA-F
AFWAL/IST
ASD/CPA
IN TURN

1. Please review the attached material for public release approval. The following information is provided in support of this request:

a. Type of information (abstract, journal article, presentation, firm/script, technical report, etc.): Technical Memorandum

b. Title: (Title of the Technical Memorandum)

c. Author(s) name, title, organization: Primary Author
Secondary Author(s)

d. Contract No./Company Name: ______

Contract (1) contains DD Form 254: ( )Yes ( )No (2) refers to a Security Classification Guide: ( )Yes ( )No

e. To be published by (name/address of publisher): ______

f. To be presented at (give sponsoring organization or technical society, location (city/state), and exact date of presentation: ______

g. Deadline for submittal (if other than presentation date): ______

2. The reverse side of this letter has been completed. (Requester must complete and sign reverse side.)

3. The information contained in this material is unclassified, technically accurate, nonproprietary, and considered suitable for public release. It contains no computer software owned or developed by or for the government. Export restrictions (i.e., MCTL, Munitions List (ITAR), and CCL) and current AF/DOD policy have been considered prior to requesting public release approval.

FOR THE COMMANDER

ASD/PA APPROVAL

______
(Division Level/Equivalent Signature
and Title)

Figure 36. Form Letter Requesting Technical Memorandum Numbers.

APPENDIX C

TABLES

C.1 TABLE 1. FIBG ACOUSTIC TESTING CAPABILITIES

SMALL TEST CHAMBER SPECIFICATIONS

Air Supply is 10,000 scfm at 3 x atmospheric pressure

1 foot by 1 foot progressive wave test section

Low frequency siren (50 Hz to 2,000 Hz; 40 kilowatt acoustic power)

High frequency siren (500 Hz to 10,000 Hz; 10 kW acoustic Power)

30 kW air modulator

Maximum sound pressure level of 174 dB in progressive wave test section

Discrete frequency, narrow-band random, or wide-band noise

Maximum panel size of 1 foot by 1.5 feet in progressive wave section

Termination Chamber is 15 feet long by 8 feet wide by 7.5 feet high

Door size is 39 inches by 85 inches

48 channels of data on a continuous basis

96 channels of data on a time-shared basis

Specimens can be heated to temperatures of 1400 degrees Fahrenheit

WIDE-BAND TEST CHAMBER SPECIFICATIONS

Air supply is 10,000 scfm at 3 x atmospheric pressure

Chamber is operated in a reverberant mode

Wide-band noise from siren (50 Hz to 10,000 Hz)

Two 30-kilowatt air modulators capable of discrete frequency narrow-band random, or wide-band noise operation

Maximum sound pressure level of 165 dB

Average physical dimensions of the chamber are 14 feet wide by 17.5 feet long by 10.5 feet high

Door size is 60 inches by 80 inches

Data from chamber are routed through 48-channel system continuous, 96-channel time-shared

C.2 TABLE 2. TABLE GENERATED USING A COMPUTER WORD PROCESSOR

RIGHT HAND NACELLE DYNAMIC PRESSURE TRANSDUCER LOCATIONS

DYNAMIC SENSOR NUMBER	DESCRIPTION		
K1	KULITE LQL series - r.h.inb'd nozzzle,norminal:theta0	= 15*	x = 0.24"
K2		= 45	
K3		= 75	
K4		= 90	
K5		= 105	
K6		= 120	
K7		= 135	
K8		= 165	
K9		= 75	x = 0.60"
K10		= 90	
K11		= 105	
K12		= 120	
K13		= 135	
K14		= 90	x = 1.44"
K15		= 105	
K16		= 135	
K17		= 105	x = 2.64"
K18	R.H. outb'd nozzle, nominal:	= 225	x = 0.24"
K19		= 240	
K20		= 255	
K21		= 270	
K22		= 317	
K23		= 255	x = 0.60"
K24		= 255	x = 1.44"
KSTRUT	Model support strut		

*Degrees

NOTE: The theta and x locations listed above are nominal values.

C.3 TABLE 3. TABLE GENERATED WITH A MICROCOMPUTER SPREADSHEET

SERIAL NUMBER	Setra (V+15-V15)/30 MFG. CAL.(mv/g)	Sensitivities SENS @ 80Hz Setra vs 902H	plot-temp-date	% DIFFERENCE FROM MFG.
120511	51.90	50.70	88-72-10/15/86	-2.31
120510	48.10	46.40	89-72-10/15/86	-3.53
114491	48.40	49.00	91-72-10/15/86	1.24
120500	48.60	49.80	93-72-10/15/86	2.47
120506	53.30	50.70	94-72-10/15/86	-4.88
120508	51.70	50.30	95-72-10/15/86	-2.71
120507	49.60	52.10	96-72-10/15/86	5.04
120503	47.80	48.20	97-72-10/15/86	.84
120509	52.00	52.10	98-72-10/15/86	.19
120505	50.70	51.30	99-72-10/15/86	1.18
120513	48.50	48.50	100-72-10/15/86	.00
120512	51.90	50.30	101-72-10/15/86	-3.08
114490	48.30	49.10	102-72-10/15/86	1.66
114488	49.60	49.40	103-72-10/15/86	-.40
120501	51.30	50.70	104-72-10/15/86	-1.17
114492	47.70	46.90	105-72-10/15/86	-1.68
114489	44.50	46.50	106-72-10/15/86	4.49
120502	55.50	55.20	107-72-10/15/86	-.54
120514	49.80	49.90	108-72-10/15/86	.20

C.4 TABLE 4. COMPUTER GENERATED TABLE

PLSQ POLYNOMIAL LEAST SQUARE CURVE FIT ERROR ANALYSIS

```
I       X= GIVEN     Y= GIVEN     Y= FITTED      ERROR       C(I)

   1 0.44900E+02 0.36000E+02 0.35771E+02-0.22859E+00 0.76881E+00
   2-0.46000E+01-0.22000E+01-0.22845E+01-0.84495E-01 0.12520E+01
   3-0.53300E+02-0.40000E+02-0.39725E+02 0.27465E+00
   4-0.54000E+02-0.40000E+02-0.40264E+02-0.26352E+00
   5-0.44000E+01-0.22000E+01-0.21307E+01 0.69266E-01
   6 0.45500E+02 0.36000E+02 0.36233E+02 0.23269E+00

EMAX: 0.27465E+00      ERMS: 0.209447E+00      EMEQ: 0.000000E+00
```

C.5 TABLE 5. HARDWARE AVAILABLE TO FIBG USERS

Description	Quantity	Location
Vax 11/780	1	Bldg24c,Room216
MassComp	1	Mobile Experimental Lab(MEL)
Decmate	3	FIBGB,FIBGD,FIBG
IBM Display writer	1	FIBGC
Zenith Z-100	6	FIBGA-Room215
		FIBGB-Room12
		FIBGC-Room
		FIBGC-Room
		FIBGD-Room10
		FIBGD-Room10
TRS Model 100	4	FIBGA-Room219
CBM8032	1	FIBGA-Room219
Commodore 64	1	
HP9816S	1	
Compac	1	
Time Data	1	
SUN Work Station	1	
Raytheon	1	
Intels	4	
Paragon(HP)	1	
6-axis calibrator		Calibration Room
UTDS-uVAX	1	On order
Zenith z-248		

C.6 TABLE 6. AVAILABLE SOFTWARE

COMPANY	Description	Computer	Operating System
Dec Standard Runoff (DSR)	Text Formatter	VAX11/780	VMS
Peachtext 5000	WP,SS,DBMS	Z-100	MS-DOS
	Word processor	CBM8032	4.0
Easyscript	WP,SS,DBMS	Commodore64	Basic
Context MBA	WP,Spread sheet,Graph	HP9816S	HP Basic
Lotus123	WP,Spread sheet,Graph	Z-100	MS-DOS
Tex	Typesetter	VAX11/780-2	VMS
Troff	Typesetter	Masscomp	unix
PISCURE	Graphs and Charts	VAX11/780-2	VMS
Plotdatatek	Graphs and plots	Vax11/780	
EDT	Text Editor	VAX11/780	VMS
Text	Text Editor	TRS M-100	
Chart	Graphs and Plots	Z-100	MS-DOS
Flexitek	Tektronix Plots	Z-100	MS-DOS

NOTES: WP=Word Processor SS=Spread sheet DBMS=Data Base Management System

APPENDIX D

TEST PLAN OUTLINE

TEST PLAN OUTLINE

I. PROBLEM DESCRIPTION: Presentation of the problem to the test group.

A. Identification of the Problem
1. Statement of the problem, its general nature and character.
2. Definitions of any special terminology employed.
3. Brief description of the system having the problem.
4. Evidence indicating present or potential problems.

B. History of the Problem
1. Chronology of events pertaining to the problem.
2. Remedial Measures taken to alleviate the problem.
3. Improvements resulting from remedial measures.
4. New problems introduced by remedial measures.

C. Extent of the Problem
1. Additional description of the system and the problem.
2. Hypotheses of the causes of the problem.
3. Possible solution methods.
4. Constraints on problem solutions.

D. Impact of the Problem
1. Lost capabilities and functions of the systems.
2. Diminished performance and efficiency of the system.
3. Cost of down time for maintenance or repair.
4. Extended demands or safety problems for personnel.

E. Suggested Scope of the Test Program
1. Types of measurements: strain, acceleration, pressure, etc.
2. Locations where sensing devices should be placed.
3. Test conditions when measurements should be recorded.
4. Types of data analysis desired.
5. Analytical or statistical models to be used.

TEST PLAN OUTLINE

II. PROGRAM OBJECTIVE: Formulation of the goals and approaches of the test program to achieve an efficient solution of the problem.

A. Problem Review and Statement
1. Review the problem description.
2. Resolve unclear areas.
3. Gather any additional information if necessary.
4. Identify any imposed solution constraints.
5. Summarize the key points into a one or two paragraph problem description.

B. Primary Program Objective
1. Hypothesize and discuss possible causes of the problem.
2. Evaluate potential solution approaches and criteria.
3. Describe the solution goal and the criteria for its evaluation in a statement of the primary program objective.

C. Secondary Objectives
1. Describe objectives of the test program which are desirable but of lower importance than the primary program objective.
2. Discuss the relative importance of these secondary objectives.

III. DATA REQUIREMENTS: Development of an overall plan for achieving the program objective.

A. Test Identification
1. Tests for quantifying noise/vibration environment
2. Tests for diagnosing sources and transmission paths
3. Tests for check or verify potential problem solutions

B. Measured Data
1. Identify data needed by each test
2. Identify data to be measured by each test
3. Identify methods to be used for applying measured data

C. Analytical Models
1. Models to be developed
   a) system characteristics
   b) sources
   c) transmission paths
   d) response prediction
2. Model parameters to be obtained from test data
3. Verification of the model
4. Demonstration of possible solution designs

TEST PLAN OUTLINE

IV. TEST PLAN DEVELOPMENT: Preparation of detailed plans describing each test.

A. Test Objective
   1. Description of measurement to be performed
   2. Data to be obtained from measurement
   3. Analysis methods to be applied to data
   4. Relation of test results to the program objective

B. Test Configuration
   1. Test object and physical configuration
   2. Variations in test object configuration to be evaluated
   3. Range of operating conditions
   4. Test site configuration and operation

C. Measurement Types and Sensor Locations
   1. Quantities to be measured
   2. Measurement transducer locations
   3. Source simulation (excitation) device locations

D. Instrumentation Requirements
   1. Measurement transducers
   2. Signal conditioning
   3. Recording and playback system

E. Data Analysis Requirements
   1. Data analysis instrumentation
   2. Data analysis parameters
   3. Types of analysis
   4. Analyzer hardware and/or software packages
   5. Data presentation parameters

F. Documentation Requirements
   1. Variations from original test plan specifications
   2. Types of intermediate results to include
   3. Presentation format for test results
   4. Long-term data storage.

V. DOCUMENTATION OF RESULTS: Preparation of test description and conclusions.

A. Problem description
B. Program objectives
C. Description of tests, measurements and analytical models
D. Presentation and evaluation of results
E. Conclusions and recommendations
   1. Analytical Models
   2. Measurement Results

APPENDIX E

SAMPLE TEST PLAN

SAMPLE TEST PLAN

A-10 GUN BAY FLIGHT
TEST PLAN

AFWAL/FIBGD

SAMPLE TEST PLAN

Prepared By: Kenneth R. Wentz
Project Engineer
Acoustics and Sonic Fatigue Group
AFWAL/FIBGD

Reviewed By: Ralph M. Shimovetz
Acting Group Leader
Acoustics and Sonic Fatigue Group
AFWAL/FIBGD

Approved By: Davey L. Smith
Branch Chief
Structural Vibration and Acoustics Branch
AFWAL/FIBG

SAMPLE TEST PLAN

1. PURPOSE

This program is in response to a support request from SM-ALC/MM. The purpose is to find a solution to the A-10A gun bay structural fatigue cracking by determining the source and applying and verifying airframe modifications to achieve the desired structural design life. The approach is to perform ground modal analysis and flight tests of the production and modified structural configurations. This test plan describes the flight test program of the production structural configuration. SM-ALC/MM's flight test aircraft, tail number 989, will be the test vehicle. The support effort was initiated in March 1986 and will be completed in December 1987. This flight test will be performed in Dec 86 - March 87 timeframe.

2. DOCUMENTATION AND AUTHORITY

This support effort is being conducted under Job Order Number AFLC8602. The complete details of the program are provided in the Support Agreement entitled "A-10 Gun Bay Test and Analysis Program" between SM-ALC/MM, ASD/AFWAL/FI and ASD/EN dated 29 May 1986, a copy of which is attached, as Appendix A.

3. BACKGROUND

A request has been received from SM-ALC/MM for the Aeronautical Systems Division's Flight Dynamics Laboratory, AFWAL/FI, and Deputy for Engineering, ASD/EN, to provide support in finding a solution to the problem of the A-10A gun bay cracking of GFU-16A gun gas diverter equipped aircraft. The A-10A is experiencing structural fatigue problems in the forward fuselage area presumably caused by firing of its gun. Although at this time this cracking is not believed to be a flight safety problem, it is a maintenance burden and could have an impact on the operational readiness of the A-10 force. This test plan outlines the flight test portion of the complete analysis effort.

4. OBJECTIVE

The objective of the complete analysis effort is to find a solution to the A-10A gun bay fatigue problem by determining the source of the structural fatigue and applying and verifying airframe modifications to achieve the desired structural design life. The objective of performing the flight test is to acquire the dynamic response data necessary to understand the problem and propose a fix.

5. SCHEDULE

The instrumentation will be installed on the AFLC/MM test aircraft beginning 15 Nov 86 and completed by 17 December 86. The flight test will begin on 6 January 87 and completed by 24 Jan 87. The data reduction will begin on 2 Feb 87 and be completed by 27 Feb 87. A test report describing the complete flight test program and acquired data will be completed by 1 April 87. The complete schedule is shown in attachment 1, Program Schedule.

6. LOCATION

The instrumentation installation and flight test will be performed at McClellan Air Force Base, California. The data reduction and analysis will be performed at Wright-Patterson Air Force Base, Ohio. Any proposed structural modifications will be performed at McClellan AFB Ca.

7. METHOD OF TEST

a.) Approach

The approach is to instrument the gun bay with strain gages, accelerometers, microphones, static pressure gages and thermocouples to acquire flight test data.

b.) Gun Bay Structural Configuration

The gun bay is shown in Figures 1 thru 14. It consists of riveted skin stiffened aluminum structure. The main areas of interest are the gun bay floor and left sidewall.

c.) Instrumentation

The instrumentation consists of 54 stain gages, 13 thermocouples, 10 microphones, 7 static pressure gages, and 10 accelerometers. Their locations are shown in Figures 15 thru 19. The locations are based on previously detected cracks and the results of the modal analysis survey. The data acquired from the flight tests will consist of; sound pressure levels, response frequencies, response strains, accelerations, temperatures and static pressure. The signal conditioning system and the transducers will be provided by AFWAL/FIBG. The signals will be recorded on the AMPEX AR 700 on-board recorder. The frequency range of interest is 0 to 500 Hz. Table 1 lists the transducer quantities and types.

d.) Flight Test Procedure

The flight test parameters which will be varied are velocity, burst length, ammonition type, and diverter configuration. Table 2 lists the parameters. The flight test altitude will be sea level and only the high firing rate will be investigated. The data will be acquired by the onboard recorder and analyzed and reduced by AFWAL/FIBG.

8. PARTICIPATING AGENCIES AND RESPONSIBILITIES

Sacramento ALC will perform the flight test. ASD/AFWAL/FI will supply and install the transducers and signal conditioning system. The data reduction and test report will be performed by ASD/AFWAL/FI. The evaluation and analysis will be performed by ASD/AFWAL/FI, ASD/EN and SM-ALC/MMET.

9. RESOURCES REQUIRED

Refer to attached Support Agreement, Appendix A.

10. COMMAND AND CONTROL

Refer to attached Support Agreement, Appendix A.

11. REPORTS

A test report describing the flight test program and acquired data will be written, 30 days after the data analysis is complete.

12. POINTS OF CONTACT

SM-ALC/MMSRC, Sherman Chan, AV 633-5300
ASD/ASD/FI, Kenneth R Wentz, AV 785-5229
ASD/EN, William Frost, AV 785-3553
SM-ALC/MMET. Vern Poetker, AV 633-5320

APPENDIX F

TRANSDUCER AND SIGNAL CONDITIONING SPECIFICATIONS

SETRA SYSTEMS, INC.
HIGH OUTPUT LINEAR ACCELEROMETER

Model 141
FOR VIBRATION, SHOCK, IMPACT
Ranges from: ±2g to ±600g
With External R_{cal} Calibration

Features

- **Excellent static and dynamic response**
- **Temperature-insensitive gas damping (0.7 critical)**
- **High output signal**
- **High overload capability, (2000g static)**
- **Low transverse sensitivity (0.005 g/g)**
- **Wide-range R_{cal} type calibration**
- **Easy-to-replace cable attachment**
- **Compact, lightweight**

Description

The Model 141 is a linear accelerometer that produces a high level instantaneous DC output signal proportional to sensed accelerations (ranging from static acceleration up to 3000 Hz as reported below).

Setra accelerometers are unique in their ability to withstand exceedingly high g overload without damage. The Model 141 incorporates the super-rugged Setra capacitance-type sensor and a new miniaturized electronic circuit.

Its excellent dynamic response is maintained by air damping, which varies with temperature approximately one-tenth as much as the best fluid damping.

The electrical characteristics are compatible with conventional strain-gage type signal conditioning, including the use of shunt R_{cal} over any selected range up to 100% full scale.

The stainless steel case is O-ring sealed, has a well defined base plane, is quite insensitive to mounting strain.

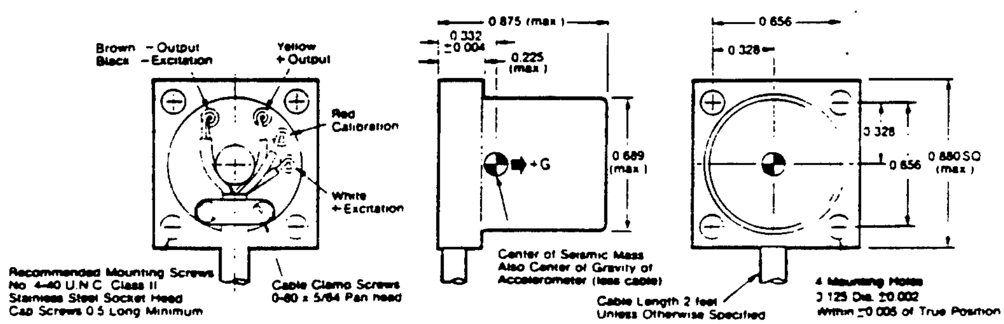
Cross axis interference is exceedingly low. The external easy-to-replace cable attachment facilitates installation and service.

Full Scale Ranges

For each of the available g ranges, the linearity is characterized by this range chart: (Non-linearity as % full range, best straight line).

Nominal Range	Non-Linearity [illegible] ±0.5%	±1%	±3%	Natural Frequency (Nominal)	Flat Response (±3 db) 0 Hz to:
[illegible]	[illegible]	±2g	±2.5g	275 Hz	200 Hz
[illegible]	[illegible]	±4g	[illegible]	330 Hz	250 Hz
[illegible]	[illegible]	±8g	±10g	350 Hz	300 Hz
±15g	±10g	±15g	±20g	800 Hz	400 Hz
[illegible]	±20g	±30g	±40g	1150 Hz	700 Hz
±60g	±40g	±60g	±80g	1600 Hz	1000 Hz
[illegible]	[illegible]	[illegible]	[illegible]	2600 Hz	1600 Hz
[illegible]	[illegible]	±600g	[illegible]	5000 Hz	3000 Hz

Outline Drawing



Note: All dimensions are in inches.

setra

45 Nagog Park, Acton, Massachusetts 01720 / Telephone: (617) 263-1400

Model 141 Specifications

Ranges, Non-Linearity, Frequency Data.	Please refer to chart on front page.
Other Accuracy Data	
Hysteresis	<±0.1%
Non-Repeatability	<±0.05% Nominal range
Transverse Acceleration Response	<±0.005 g/g
Damping	Approximates second order system with 0.7 critical damping. The frequency band for all ranges is flat from static to approximately 60% of the natural frequency. Damping is gas squeeze-film, 0.7 ±0.2 of critical at 77°F. Damping ratio increases approximately 0.15%/°F.
Resolution	Infinite, limited only by output noise level.
Thermal Effects	Operating temperature −10°F to 150°F Zero shift <±0.02% Nominal Range/°F Sensitivity shift <±0.02% Nominal Range/°F Slightly higher thermal effects when 141A is operated at excitation voltage below 10VDC. Model 141A (special order) −65°F to 220°F
Zero G Output	<±25 mv (factory calibrated at designated excitation)
Noise Level	<±0.01% Nominal Range (RMS, in-band)
Calibration Data	Each unit is supplied with a full scale continuous plot of output vs. acceleration (centrifuge), at a designated excitation voltage. Sensitivity is reported at Nominal Range. Model 141A calibrated at 10VDC excitation. Model 141B calibrated at 24VDC excitation.
Electrical Data	
Electrical Circuit	Three-terminal equivalent, common -excitation and -output signal. Circuit is capacitively isolated from case, greater than 100 megohm isolation. Power applied to output, or shorted output, will not damage unit. No reverse excitation protection. Operates at internal frequency approximately 20 MHz. Model 141B operable on regulated 28 VDC aircraft power, (recommend high voltage transient protection to prevent damage by emergency power conditions as defined in MIL-STD-704A, and voltage regulation to attain highest accuracy).
Calibration Signal (R_{cal})	Available up to 100% Nominal Range by shunting external calibration resistor from calibration lead to -signal lead.
Voltages and Currents	Two versions are available, offering your choice of units for different excitation voltages. Output is proportional to excitation voltage. Output impedance 9K ohms (nominal).

Typical performance for nominal G range:

Model	Range	Voltage [illegible]	Excitation Current	Output (ope[illegible]
[illegible]	[illegible]	[illegible]	[illegible] milliamperes	[illegible]500 [illegible]
[illegible]	[illegible]	[illegible]	[illegible]0 milliamperes	[illegible]000 [illegible]

Cable, Weight, Case	
Electrical Connection	2 foot multiconductor cable
Weight	30 grams (not including cable)
Case	Stainless steel, O-ring sealed

Ordering Information

Specify:	Model 141A or Model 141B
Specify G Range:	Nominal Range (±specific g)
Specify:	Excitation voltage for calibration (if non-standard, at extra charge)

Specifications subject to change without notice

Setra systems INC

45 Nagog Park, Acton, Massachusetts 01720 / Telephone: (617) 263-1400

SETRA ACCELEROMETERS

Setra Systems INC.
45 Nagog Park
Acton, Massachusetts 01720
(617) 263-1400
Telex: 94-8440

Description

Setra accelerometers are linear acceleration transducers that produce a high level DC output signal proportional to sensed acceleration. This is accomplished by means of a unique capacitance-type acceleration sensor and a miniaturized rugged electronic circuit, all contained within the accelerometer.

Sensor

The variable-capacitance type sensors consists of a thin stiff metal disc and flexures assembled between two fixed insulated electrodes. The position of the seismic disc in relation to the two electrodes is proportional to the acceleration vector perpendicular to the electrodes.

"Squeeze-film" gas damping (air) assures constant amplitude response over a wide temperature range, approximating 0.7 critical damping.

This rugged structure exhibits very low hysteresis and withstands very high g overloads. Cross-axis sensitivity is extremely low. The sensor has full dynamic response down to 0 Hertz, thus giving static g output as well.

Circuit

The circuits are DC in/DC out, draw low current, produce high output signals, eliminate cable noise and interference pickup problems often associated with the use of low level output accelerometers.

Model 141
Has 3-terminal circuit; can use calibration resistor for calibration signal; has 9000 ohms output impedance.

Model	Excitation Range	At Excitation Voltage of:	Excitation Current	Nominal Output (Open Circuit)
141A	5VDC-15VDC	10VDC	5 milliamperes	+400 millivolts
141B	10VDC-28VDC	24VDC	10 milliamperes	±1000 millivolts

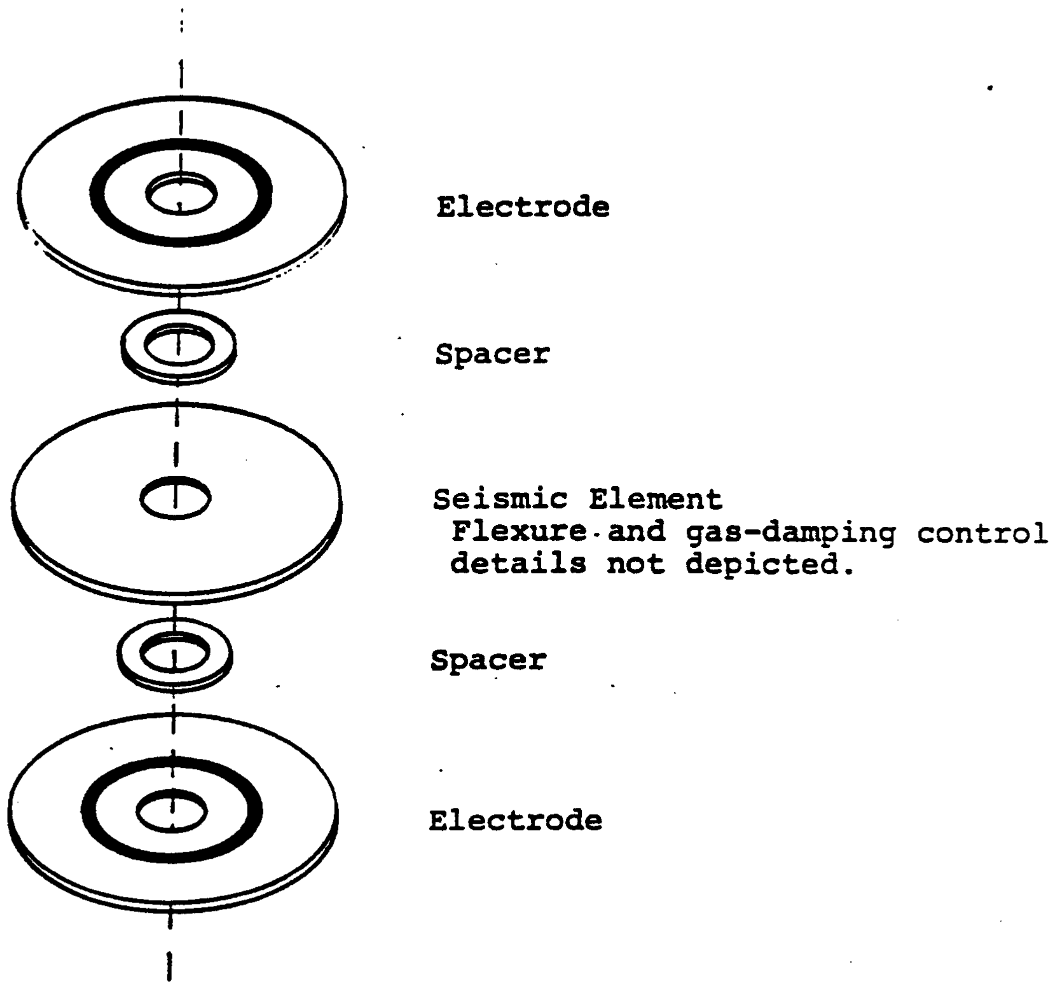
Benefits Using Setra Accelerometers

Can withstand high g overloads without damage.
Full static and dynamic response.
High Accuracy:
- < 1% non-linearity
- < 1% cros-axis sensitivity

High output signal eliminates cable noise problems or need for further amplification.

3-82

Rcvd 1/26/86



SETRA SYSTEMS

CAPACITANCE-TYPE ACCELERATION SENSOR

IN MODEL 141 ACCELEROMETER

45 Nagog Park, Acton, Massachusetts 01720 (617) 263-1400

Setra Systems INC

10/24/84 Ex 9 Bldg 65 From F Huang

M-M ENGINEERING DATA SHEET

THE INFORMATION APPEARING ON THIS SHEET HAS BEEN COMPILED SPECIFICALLY FOR THE GAGES CONTAINED IN THIS PACKAGE. THIS FORM IS PRODUCED WITH ADVANCED EQUIPMENT & PROCEDURES WHICH PERMIT COMPREHENSIVE QUALITY ASSURANCE VERIFICATION OF ALL DATA SUPPLIED HEREIN. SHOULD ANY QUESTIONS ARISE RELATIVE TO THESE GAGES, PLEASE MENTION GAGE TYPE, ITEM NUMBER, AND LOT NUMBER.

Item	Code	Check	Final QA
5391-1D	942719	I.R.A.	C.B.P.

M-M Micro-Measurements Division
MEASUREMENTS GROUP, INC.
RALEIGH, NORTH CAROLINA

PRECISION STRAIN GAGES

	EA-06-125PC-350
GAGE TYPE	EA-06-125PC-350
RESISTANCE IN OHMS	350.0 ± 0.2%
GAGE FACTOR AT 75° F	2.06 ± 0.5%
K_t	+0.2%
LOT NUMBER	R-A38AD433
QUANTITY	5 GAGES
OPTION	

GENERAL INFORMATION: SERIES EA STRAIN GAGES

GENERAL DESCRIPTION: EA Series Gages are a general purpose family of constantan strain gages widely used in experimental stress analysis. These gages are of open-faced construction with a 1 mil *(0.03mm)* tough, flexible polyimide film backing.

TEMPERATURE RANGE: -100°F *(-75°C)* to +350°F *(+175°C)* for continuous use in static measurements, -320°F *(-195°C)* to +400°F *(+205°C)* for special or short term exposure.

SELF-TEMPERATURE COMPENSATION: See data curve below.

STRAIN LIMITS: Approximately 5% for gage lengths 1/8" *(3.2mm)* and larger; and approximately 3% for gage lengths under 1/8" *(3.2mm)*.

FATIGUE LIFE: 10^5 cycles at ±1200μ"/" *(μm/m)*; 10^6 cycles at ±1500μ"/" *(μm/m)*; 10^7 cycles at ±1800 μ"/" *(μm/m)*. 10^7 cycles at 2800μ"/" *(μm/m)* unidirectional, tension or compression only. Larger gage lengths and lower resistances result in greater endurance and less scatter in fatigue life.

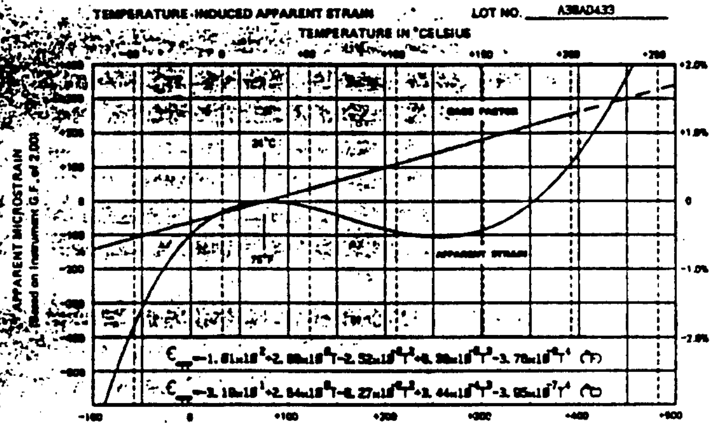
CEMENTS: Compatible with M-M Certified M-Bond 200 but it will normally not provide the greatest fatigue life. Micro-Measurements' M-Bond AE-10/15, M-Bond GA-2, M-Bond 600, and M-Bond 610 are excellent. M-Bond 610 is the best choice over the entire operating range. Refer to M-M Bulletin A-142 for information on bonding agents, and Bulletins B-127, B-130, and B 137 for installation procedures.

SOLDER: If operating temperature will not exceed +300°F *(+150°C)*, M-Line solder type 361 (63-37) tin-lead solder may be used for lead attachment. M-Line solder type 460 (95-5) tin-antimony is satisfactory to +400°F *(+205°C)*. When solder terminals (Option S) are supplied on these gages, they are formed with +570°F *(+300°C)* lead-tin silver solder alloy. Refer to M-M Bulletin A-132 for further information on solder, and Bulletin TT-127 and TT-128 for lead attachment techniques.

PROTECTIVE COATINGS: These EA open-faced gages should always be protected with a suitable coating that is applied as soon as possible after gage installation. Refer to M-M Bulletin A-134 for information on Strain Gage Protective Coatings.

BACKING: The backing of EA Series Gages has been specially treated for optimum bond formation with all appropriate strain gage adhesives. No further cleaning is necessary if contamination of the prepared surface is avoided during handling.

TEMPERATURE-INDUCED APPARENT STRAIN — LOT NO. A38AD433



TESTED ON: 1018 STEEL — CODE: 943712 — ENG. R.S.B.

TEST PROCEDURES USED BY MICRO-MEASUREMENTS FOR STRAIN GAGE PERFORMANCE EVALUATION

OPTICAL DEFECT ANALYSIS	M-M Procedures and Standards
GAGE FACTOR AT 75°F	ASTM E251-67 (Constant Stress Cantilever Method) *
G.F. VARIATION WITH TEMPERATURE	ASTM E251-67 (Step Deflection Method)
APPARENT STRAIN VERSUS TEMPERATURE	ASTM E251-67 (Slow Heating Rate, Continuously Recorded)
TRANSVERSE SENSITIVITY	ASTM E251 67
INITIAL RESISTANCE	M-M Procedure, Direct NBS Traceability on Resistance Standards
FATIGUE LIFE	NAS 942 (Modified)
STRAIN LIMITS	NAS 942 (Modified)
GAGE THICKNESS	M-M Procedure
CREEP AND DRIFT	M-M Procedure (Similar to NAS 942 Method)

*Gage factor data are obtained in a uniaxial stress field with Poisson's ratio of approximately 0.285

HCD SERIES—HERMETICALLY SEALED (CONNECTOR TERMINATION)

- HERMETICALLY SEALED BY TIG AND EB WELDING
- IMPERVIOUS TO HOSTILE ENVIRONMENTS

HCD Series units are similar to the DC-D Series. Tungsten inert gas (TIG) and electron beam (EB) welding provide hermetic sealing that is free from oxidation-producing faults that may cause leakage. For this reason, HCD Series LVDT's are impervious to dirt, water, steam spray, and most corrosives. They have been qualified at pressures up to 1000 psig (70 bars) and are suitable for numerous high-pressure applications. They are terminated with a glass-sealed, MS-type terminal connector. The connector prohibits the core from passing completely through the coil assembly. Where through-bore operation is required, see the HPD Series. HCD units have double magnetic shielding that makes them insensitive to external magnetic influences.

GENERAL SPECIFICATIONS

Input	±15 V DC (nominal), ± 20 mA
Operating Temperature Range	0°F to +160°F (-18°C to +70°C)
Survival Temperature Range	-65°F to +200°F (-55°C to +95°C)
Null Voltage	0 V DC
Ripple	Less than 1% full scale
Linearity	± 0.25% full range
Stability	0.125% full scale
Temperature Coefficient of Scale Factor	0.04%/°F (0.08%/°C)
Shock Survival	250 *g* for 11 milliseconds
Vibration Tolerance	10 *g* up to 2 kHz
Coil Form Material	High density, glass-filled polymer
Housing Material	AISI 400 series stainless steel
Electrical Termination	6-pin connector
Output Impedance	100 Ohms
Min. Load Resistance	2000 Ohms

PERFORMANCE SPECIFICATIONS AND DIMENSIONS

LVDT MODEL NUMBER	NOMINAL LINEAR RANGE	SENSITIVITY SCALE FACTOR	RESPONSE -3dB	WEIGHT Grams		DIMENSIONS A (Body)	B (Core)	C	P
	Inches	V/Inch	Hz	Body	Core	Inches	Inches	Inches	Inches
050 HCD	±0.050	200	500	40	2	2.40	0.59	1.90	0.55
125 HCD	±0.125	80	500	50	3	3.23	1.10	2.73	0.96
250 HCD	±0.250	40	500	62	5	4.10	1.80	3.60	1.39
500 HCD	±0.500	20	500	82	9	5.79	3.00	5.29	2.23
1000 HCD	±1.000	10	200	120	10	8.05	3.80	7.55	3.32
2000 HCD	±2.000	5.0	200	174	13	11.42	5.30	10.92	5.05
3000 HCD	±3.000	3.3	200	236	14	16.62	6.20	16.10	7.59
5000 HCD	±5.000	2.0	200	294	17	20.45	6.20	19.95	9.56
10000 HCD	±10.00	1.0	200	526	24	34.57	12.00	34.03	16.61

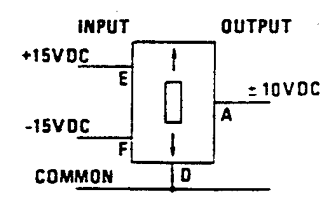
the one we have now

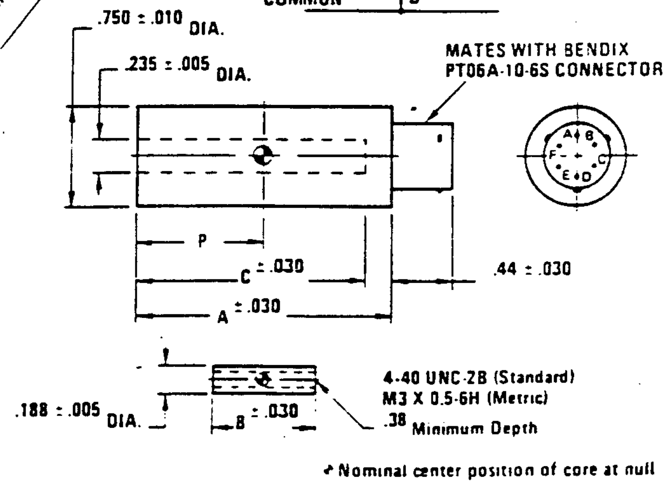
ORDERING INFORMATION

(Fold out page 32 for instructions on how to use this chart.)

OPTION NO.	006	010	020	040	080	200
	METRIC THREAD CORE (NOTE 1)	TEFLON BORELINER	SMALL DIAMETER CORE (NOTE 2)	10 FOOT (3m) LEADS	MILDLY RADIATION RESISTANT	0.1% LINEARITY
MODEL NO.						
050 HCD	N	B	B	–	X	X
125 HCD	N	B	B	–	X	X
250 HCD	N	B	B	–	X	X
500 HCD	N	B	B	–	X	X
1000 HCD	N	B	B	–	X	X
2000 HCD	N	B	X	–	X	X
3000 HCD	N	B	X	–	X	X
5000 HCD	N	B	X	–	X	X
10000 HCD	N	B	X	–	X	X

Note 1 See outline drawing for metric thread size
Note 2 Consult factory for mass, dimensions, and thread size





* Nominal center position of core at null

SEE SCHAEVITZ SERIES 70 BULLETINS FOR COMPATIBLE SIGNAL-CONDITIONING AND READOUT EQUIPMENT

HPD SERIES—HERMETICALLY SEALED (PIN TERMINATION)

- HERMETICALLY SEALED BY TIG AND EB WELDING
- IMPERVIOUS TO HOSTILE ENVIRONMENTS
- THROUGH-BORE CONSTRUCTION

HPD Series units are similar to the DC-D and HCD Series. Tungsten inert gas (TIG) and electron beam (EB) welding provide hermetic sealing that is free from oxidation-producing faults that may cause leakage. For this reason, HPD Series LVDT's are impervious to dirt, water, steam spray, and most corrosives. They have been qualified at pressures up to 1000 psig (70 bars) and are suitable for numerous high-pressure applications. HPD units employ a glass-sealed, pin-terminal header that allows the core and core rod to pass through the unit. HPD units have double magnetic shielding that makes them insensitive to external magnetic influences.

GENERAL SPECIFICATIONS

Input	±15 V DC (nominal), ±20 mA
Operating Temperature Range	0°F to +160°F (-18°C to +70°C)
Survival Temperature Range	-65°F to +200°F (-55°C to +95°C)
Null Voltage	0 V DC
Ripple	Less than 1% full scale
Linearity	±0.25% full range
Stability	0.125% full scale
Temperature Coefficient of Scale Factor	0.04%/°F (0.08%/°C)
Shock Survival	250 *g* for 11 milliseconds
Vibration Tolerance	10 *g* up to 2 kHz
Coil Form Material	High density, glass-filled polymer
Housing Material	AISI 400 series stainless steel
Electrical Termination	6-pin terminal header
Output Impedance	100 Ohms
Min. Load Resistance	2000 Ohms

PERFORMANCE SPECIFICATIONS AND DIMENSIONS

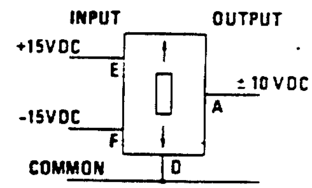
LVDT MODEL NUMBER	NOMINAL LINEAR RANGE	SCALE FACTOR	RESPONSE −3dB	WEIGHT Grams		DIMENSIONS A (Body)	B (Core)	P
	Inches	V/Inch	Hz	Body	Core	Inches	Inches	Inches
050 HPD	±0.050	200	500	36	2	2.40	0.59	0.55
125 HPD	±0.125	80	500	45	3	3.23	1.10	0.96
250 HPD	±0.250	40	500	57	5	4.10	1.80	1.39
500 HPD	±0.500	20	500	77	8	5.79	3.00	2.23
1000 HPD	±1.000	10	200	115	10	8.05	3.80	3.32
2000 HPD	±2.000	5.0	200	169	13	11.42	5.30	5.05
3000 HPD	±3.000	3.3	200	231	14	16.62	6.20	7.59
5000 HPD	±5.000	2.0	200	288	17	20.45	6.20	9.56
10000 HPD	±10.00	1.0	200	520	24	34.57	12.00	16.61

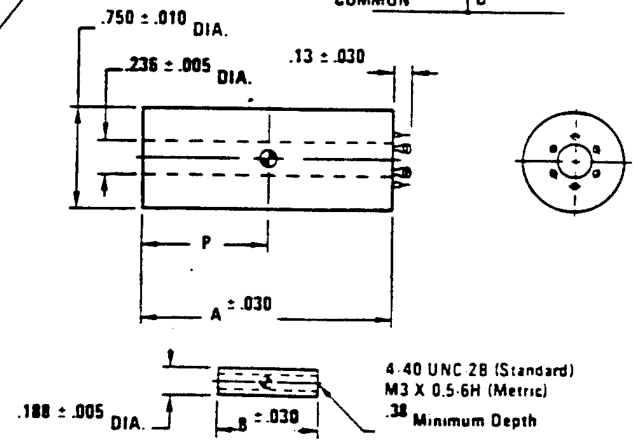
ORDERING INFORMATION

(Fold out page 32 for instructions on how to use this chart.)

	METRIC THREAD CORE (NOTE 1)	TEFLON BORELINER	SMALL DIAMETER CORE (NOTE 2)	10 FOOT (3m) LEADS	MILDLY RADIATION RESISTANT	0.1% LINEARITY
OPTION NO.	006	010	020	040	080	200
MODEL NO.						
050 HPD	N	B	B	–	X	X
125 HPD	N	B	B	–	X	X
250 HPD	N	B	B	–	X	X
500 HPD	N	B	B	–	X	X
1000 HPD	N	B	B	–	X	X
2000 HPD	N	B	X	–	X	X
3000 HPD	N	B	X	–	X	X
5000 HPD	N	B	X	–	X	X
10000 HPD	N	B	X	–	X	X

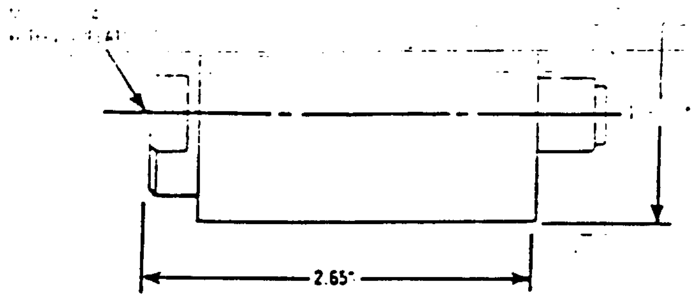
Note 1: See outline drawing for metric thread size
Note 2: Consult factory for mass, dimensions, and thread size





* Nominal center position of core at null

SEE SCHAEVITZ SERIES 70 BULLETINS FOR COMPATIBLE SIGNAL-CONDITIONING AND READOUT EQUIPMENT



SPECIFICATIONS

Pressure Ranges	0-100, 0-150, 0-200, 0-250, 0-300, 0-500, 0-750, 0-1000, 0-1500, 0-2000, 0-2500, 0-3000, 0-3500, 0-4000, 0-5000, 0-7500, 0-10,000, 0-15,000, 0-20,000 PSIA or PSIS (14.7 PSIA reference), or true PSIG.
Measurand Fluids	All fluids compatible with 17-4PH stainless steel. Options available.
Full Scale Output	5.00 ± 0.050 volts DC for 10K ohm load or greater. Calibrated with 50K ohm load.
Zero Balance	0.000 ± 0.050 volts DC at +70°F.
End Point Linearity	Within ± 0.25% FSO for 0-100 thru 0-500 PSI ranges. Within ± 0.15% FSO for 0-750 thru 0-20,000 PSI ranges.
Hysteresis	Less than 0.10% FSO.
Repeatability	Within ± 0.10% FSO.
Resolution	Infinite
Natural Frequency	0-100 PSI range .... 9.2KHz 0-150 PSI range .... 10KHz 0-200 PSI range .... 11KHz 0-250 PSI range .... 13KHz 0-300 PSI range .... 10KHz 0-500 PSI range .... 13KHz 0-750 PSI range .... 15KHz 0-1000 PSI range .... 18KHz 0-1500 PSI range .... 23KHz 0-2000 PSI range .... 28KHz 0-2500 PSI range .... 33KHz 0-3000 PSI range .... 37KHz 0-5000 PSI range .... 56KHz 0-7000 PSI range .... 77KHz 0-10,000 PSI range .... 96KHz 0-15,000 PSI range .... 126KHz 0-20,000 PSI range 146KHz
Proof Pressure	0-100 thru 0-300 PSI ranges: 4.0 times range. 0-500 thru 0-20K PSI ranges: 2.0 times range. Pressure can be applied without causing change in performance characteristics.
Burst Pressure Rating	0-100 thru 0-300 PSI ranges: 6.0 times range. 0-500 thru 0-20K PSI ranges: 3.0 times range.
Compensated Temperature Range	−30°F to +170°F. Options available.
Operating Temperature Range	−100°F to +250°F.
Thermal Sensitivity Shift	Less than ± 0.005% FSO per °F over compensated temperature range.
Thermal Zero Shift	Less than ± 0.010% FSO per °F over compensated temperature range.
Triaxial Mechanical Shock	30 G's applied for 11 milliseconds will not cause change in performance characteristics.
Triaxial Acceleration Error	Less than ± 0.005% FSO per G.
Triaxial Vibration Error	Less than ± 0.005% FSO per G. 30G peak, 50 to 2000 Hz, or 1.0 inch DA from 5 to 50 Hz.
Excitation	20 to 36 volts DC unregulated. Reverse polarity protected. ± 100 volt 10 micro-second spikes will not cause permanent damage.
Current Drain	Less than 35 madc.
Output Impedance	Less than 25 ohms.
Output Noise	Less than 15 millivolts peak to peak.
Insulation Resistance	Greater than 1000 megohms at 50 VDC between all terminals in parallel and the case at a temperature of +70°F.
DC Isolation	Greater than 1000 megohms at 50 VDC from excitation to signal output terminals.
Pressure Fitting	7/16-20 internal thread per MS33649-4 is standard. Options available.
Pressure Cavity Volume (excluding pressure fitting)	0-100 thru 0-750 PSI ranges .... 0.05 cu. in. 0-1000 thru 0-5000 PSI ranges ...... 0.025 cu. in. 0-7500 thru 0-20,000 PSI ranges ...... 0.015 cu. in.
Electrical Receptacle	Mates with Bendix PCS06E-8-4S(SR). Standard wiring: Excitation +A, −D; Signal +B, −C. Options available.
Enclosure	Entirely welded and hermetically sealed stainless steel.
Weight	Less than 8 ounces.

Terminology in accordance with ISA Recommended Practice RP37-3.

WARRANTY

[illegible]edyne Taber, hereinafter designated as the Company, warrants that any [illegible] of parts of the product which, under normal operating conditions in the [illegible] of the original purchaser thereof, proves defective in material or workmanship within one year from the date of shipment by the Company, as determined by an inspection by the Company, will be repaired or replaced [illegible] of charge provided that the original purchaser promptly sends to the [illegible] the defective material, transportation charges prepaid, with notice [illegible] the defect and establishes that the product has been properly installed, maintained and operated within the limits of rated and normal usage. Replacement parts will be shipped F.O.B. the Teledyne Taber plant. The terms of this Warranty do not in any way extend to part or parts of the product thereof which has a life under normal usage inherently shorter than the one year indicated above. Said Warranty in respect to replacement of defective parts and any such additional warranty or representation expressly made are in lieu of all other warranties expressed or implied including any implied warranty of merchantability or fitness for any particular purpose.

Warranty specifications and qualitative calibration data as supplied with each transducer are based on tests performed on and values obtained with N.B.S. traceable laboratory standards and test equipment of Teledyne Taber.

TELEDYNE TABER

455 Bryant St., N. Tonawanda, N.Y. 14120 • Phone: 716-694-4000 • TWX: 710-262-1264

Bulletin 2403-76

Litho in U.S.

PRESSURE TRANSDUCER

PRESSURE RANGES

0-100	0-2500
0-150	0-3000
0-200	0-3500
0-250	0-4000
0-300	0-5000
0-500	0-7500
0-750	0-10,000
0-1000	0-15,000
0-1500	0-20,000 PSIA or PSIS
0-2000	(14.7 PSIA ref. — or true PSIG).

0-5V DC isolated output signal

- Entirely welded stainless steel pressure media cavity.
- DC isolation from signal output to excitation.
- 5.00 ± 0.050 volts DC output for 10K ohm load.
- 20-36 volts DC unregulated excitation.
- Output short circuit protected.
- Rigid-edge-supported diaphragm sensing element with four active foil strain gages thermal-epoxy-bonded to controlled stress zones. Ultra-low hysteresis and non-repeatability error are primary features of design.

OPTIONS AVAILABLE

- Internal shunt for tracking FSO throughout compensated temperature range.
- Pressure fitting per MS33656-4, ¼-NPT, AE F250C or Cajon 4VCR internal or external thread.
- Electrical receptacle to mate with MS3116-10-6S.
- Compensation available for any range within −100°F to +250°F.
- Alternate pressure media cavity materials.

TELEDYNE TABER

BCD/BINARY - PROGRAMMABLE LOWPASS ACTIVE FILTERS 744/745 SERIES

SPECIFICATIONS
(Typical @ 25° C and V_s = ± 15V unless noted)

DC GAIN (Non-Inverting)	0 ± 0.02dB
CORNER FREQUENCY	
Tolerance	± 3%
Stability	± 0.02%/°C
Tuning Linearity	± 1%
INPUT	
Impedance	10^9 Ω
Voltage Range	± 10V
Maximum Safe Voltage	± V_s
Bias Current	30nA
OUTPUT[1]	
Resistance	1 Ω
Linear Operating Range	± 10V
Maximum Current	2mA
Offset Voltage	See Figure 3.2
Offset Drift	75µV/°C
Noise[2]	75µV RMS
POWER SUPPLY[3] (± V_s)	
Rated Voltage	± 15Vdc
Operating Range	± 5 to 18Vdc
Maximum Safe Voltage	± 18Vdc
Quiescent Current	± 22mA
TEMPERATURE	
Operating	0 to + 70°C
Storage	− 25 to + 85°C

2~
40
880 ma

NOTES: (Signal voltages are all referenced to supply common)
1) Short circuit protected to ground. DO NOT CONNECT TO ± V_s.
2) Measured RMS output 1Hz to 50kHz with input grounded, excluding dc.
3) The power supply must provide a positive voltage source, a negative voltage source and a common (ground) connection.

22 ma
x 40
880 ma ±

F21-679-02

BCD/BINARY - PROGRAMMABLE LOWPASS ACTIVE FILTERS 744/745 SERIES

CORNER FREQUENCY PROGRAMMING

The corner frequency of a 744/745 Series filter is programmed in accordance with the bit/frequency weightings listed in each model-column of Table 2. To obtain an in-limit corner frequency between the listed values, simply select those bits from the model-column of interest whose frequency weights add up to the desired corner frequency.

Referring to Figure 3.1, the selection of Bit N is achieved by externally connecting pins A_N and B_N to their assigned common, pin A/BO. In the same way, connect pins C_N and D_N to their associated common, pin C/DO. The subscript N denotes the number of the selected bit (or step) and assumes integral values from 1 to 11.

When, for example, programming the Model 744PL-3 for a 500Hz corner frequency, Table 2 calls for selecting bits 5 and 7. This requires bit weightings of 100 and 400Hz, for a resulting f_c of 500Hz. Figure 3.1 illustrates these connections, in which pins A_5 and B_5 along with pins A_7 and B7 individually connect to A/BO, while pins C_5, D_5, C_7 and D_7 individually connect to the C-D common, pin C/DO.

CAUTION: DO NOT PROGRAM THE CORNER FREQUENCY ABOVE THE FMAX LISTED IN TABLE 2. LEAVE ALL UNSELECTED PINS OPEN.

CORNER FREQUENCY PROGRAMMING BITS FOR THE 744/745 SERIES

744 SERIES

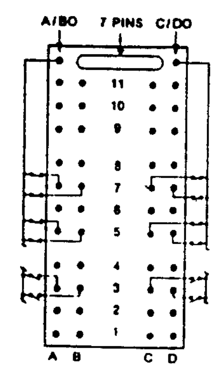
STEP	744PB-1 744PL-1 (Hz)	744PB-2 744PL-2 (Hz)	744PB-3 744PL-3 (Hz)	744PB-4 744PL-4 (Hz)	744PB-5 744PL-5 (Hz)
11	40	400	4000	40K	—
10	20	200	2000	20K	20K
9	10	100	1000	10K	10K
8	8	80	800	8K	8K
7	4	40	400	4K	4K
6	2	20	200	2K	2K
5	1	10	100	1K	1K
4	0.8	8	80	800	800
3	0.4	4	40	400	400
2	0.2	2	20	200	200
1	0.1	1	10	100	100
f_{max}	80	800	8000	80K	20K

745 SERIES

BIT	745PB-1 745PL-1 (Hz)	745PB-2 745PL-2 (Hz)	745PB-3 745PL-3 (Hz)	745PB-4 745PL-4 (Hz)	745PB-5 745PL-5 (Hz)
10	25.6	256	2.56K	25.6K	10.24K
9	12.8	128	1.28K	12.8K	5.12K
8	6.4	64	640	6.4K	2.56K
7	3.2	32	320	3.2K	1.28K
6	1.6	16	160	1.6K	640
5	0.8	8	80	800	320
4	0.4	4	40	400	160
3	0.2	2	20	200	80
2	0.1	1	10	100	40
1	0.05	0.5	5	50	20
f_{max}	51.2	512	5.12K	51.2K	20.48K

DO NOT PROGRAM THE CORNER FREQUENCY OVER THE SPECIFIED f_{max}

TABLE 2

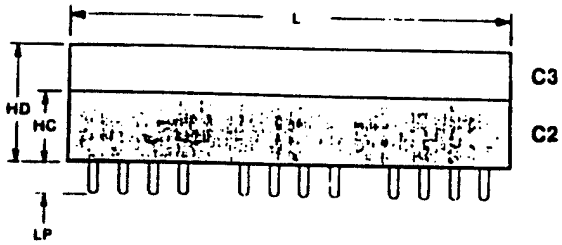


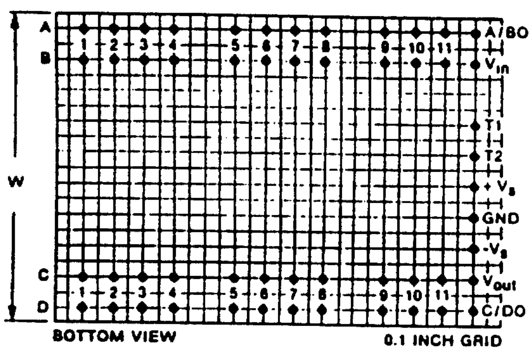
BOTTOM VIEW
TYPICAL UNPROGRAMMED BITS
Model 744PL-3 tuned for f_c = 500 Hz
Figure 3.1

F21-679-03

FREQUENCY DEVICE 744|745

OUTLINE DIMENSIONS





NOTE: Pins 11A, B, C, and D are not present on 745 units and on 744-5 units.

DIMENSION	MILLIMETERS	INCHES
L	76.2	3.0
W	50.8	2.0
HC	15.2	0.6
HD	25.4	1.0
LP	5.08 min	0.2 min
PIN DIA	1.02	0.04

F21-679-10

FREQUENCY DEVICES, INC.
25 Locust St., Haverhill, MA 01830
TEL 617-374-0761
TWX 710-347-0314

**ACCESSORY INTERFACE CARDS
DIMENSIONS IN MM (INCHES)**

**MODEL FC-102
(ON-CARD-SWITCH-PROGRAMMABLE)**

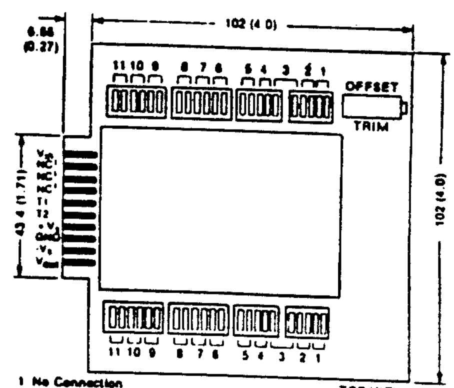


Figure 5.1

MODEL FC-101

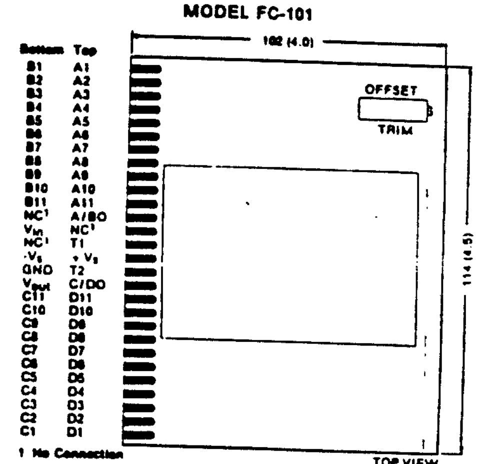


Figure 5.2

F21-679-11

FREQUENCY DEVICES, INC.
25 Locust St., Haverhill, MA 01830
TEL 617-374-076
TWX 710-347-031

FREQUENCY DEVICE 744|745

H101 Honeywell 101

General

Size .... 24 inches (61 cm) H × 17.5 inches (44.5 cm) W × 16.25 inches (41.3 cm) D.
Weight .... Average 14-channel record/reproduce system approx 100 lb (45.4 kg)
Input Supply .... 105 to 127V ac (210-254V ac available), 47 to 63 Hz, single phase
Power Consumption .... approx 480W
Temperature (tape limited)
Operating .... 0 to 50°C (32 to 122°F)
Storage .... −30 to +75°C (−22 to +167°F)
Altitude
Operating .... to 4500 m (15,000 ft)
Storage .... to 15,000 m (50,000 ft)
Humidity (tape limited) .... 5 to 95% (noncondensing)

Tape Transport

Tape Speeds .... 8 speeds: 120, 60, 30, 15, 7.5, 3.75, 1.87, and 0.937 ips. All speeds are bidirectional and electrically selectable by push-button switches.
Tape Width .... ½ and 1 inch
Tape Thickness .... 0.7 to 1.5 mil
Tape Reels .... 10½ to 15-inch dia. coaxially mounted
Reel Hubs .... 3 inch NAB precision
Tape Speed Accuracy .... 0.1% when servoed from capstan tachometer with 1.0 mil tape, 0.01% when servoed from tape.
Start Time .... 8 sec max at 120 ips with 15-inch reels
Stop Time .... 8 sec max at 120 ips with 15-inch reels
Fast Mode .... 180 ips
Static Skew .... Reproduce head azimuth adjustable to reduce static skew to less than ±0.5 μsec between outside tracks on a single head stack at 120 ips.
Dynamic Skew (ITDE) .... Measured between outside tracks of a single 1-inch head stack over 10 sec. Test frequency of 100 kHz at 120 ips, proportionately lower at other speeds.

Tape Speed (ips)	ITDE(0 to pk) (μsec)
120	1.1
60	2.2
30	4.4
15	8.8
7.5	17.6
3.75	35.2
1.87	70.4
0.937	140.8

Flutter .... ½ and 1 inch tape, cumulative, pk-pk, measured per IRIG 106-75, servoed from capstan tachometer in record and reproduce:

Tape Speed (ips)	Band width (Hz)	Flutter pk-pk (%)
120	0.5 - 10,000	0.18
60	0.5 - 10,000	0.20
30	0.5 - 5000	0.20
15	0.5 - 2500	0.23
7.5	0.5 - 1250	0.27
3.75	0.5 - 625	0.30
1.87	0.5 - 313	0.33
0.937	0.5 - 156	0.40

Local Control .... Push-button controls: FOOTAGE RESET, SHUTTLE SET, TRACK SEQUENCE SET, DISPLAY, REVERSE, FORWARD, FAST, STOP (load), RECORD, LOW TAPE, SHUTTLE, TRACK SEQUENCE, TRANSPORT SEQUENCE, TAPE (tape/tach select), REMOTE, PREAMBLE, CALIBRATE, eight speeds, dual-function 10-digit keyboard, and POWER.

Footage Counter .... All-electronic, bidirectional true footage counter with 5-digit solid-state LED readout to 19,999 and −19,999.
Shuttle .... All electronic, solid-state, may shuttle between any two selected points on the tape, between any point on the tape and either BOT or EOT, or between BOT and EOT. Shuttle points are operator keyboard programmable. Shuttle points may be displayed during operation.

Direct Record/Reproduce

Specifications listed apply to operation with standard IRIG 50 mil track widths without an FM channel on an adjacent track in the same head stack. Signal rms/noise rms specifications for 28 track, 25 mil track widths are reduced 3 dB from those listed.

Harmonic Distortion .... Normal record level set for 1% third harmonic distortion of a signal recorded at 0.1 bandedge at 60 ips.
Input Level .... 0.1 to 7V rms, adjustable
Input Impedance .... 20 kΩ, or 75Ω selectable by jumper pin.
Normalized Output .... 1.0V rms for record levels between 0.5 and 3.0% THD
Output Level .... 1V rms into 50Ω
Output Impedance 50Ω
Amplitude and Phase Equalization .... All eight drive speeds, standard
Group Delay .... ±250 nsec: measured between 100 kHz and 1.6 MHz at 120 ips. Proportionately higher at lower tape speeds (2.0 MHz System)

Dynamic Characteristics, 600 kHz System

Tape Speed (ips)	Bandwidth ±3 dB (kHz)	Signal rms/Noise rms (dB)[①]
120	0.3 - 600	41
60	0.3 - 300	41
30	0.15 - 150	40
15	0.1 - 75	39
7.5	0.1 - 37.5	38
3.75	0.1 - 18.7	38
1.87	0.1 - 9.3	37
0.937	0.1 - 4.7	35

Dynamic Characteristics, 2 MHz System

Tape Speed (ips)	Bandwidth ±3 dB (kHz)	Signal rms/Noise rms (dB)[①]
120	0.4 - 2000	26
60	0.4 - 1000	27
30	0.4 - 500	27
15	0.4 - 250	26
7.5	0.4 - 125	25
3.75	0.4 - 62.5	24
1.87	0.4 - 31.25	21
0.937	0.4 - 15.00	19

① Measured at the output of a bandpass filter having 18 dB/octave attenuation beyond bandwidth limits and using recommended tapes.

FM Record/Reproduce

FM record amplifiers may be operated at ±40% IRIG WB Gp I, Intermediateband or ±30% IRIG WB Gp II modes. Filters are pin jumper selectable for flat amplitude or transient response characteristics. Specifications shown are for flat amplitude mode. In transient mode, the output will be down 6 dB at bandedge.

Linearity .... ±0.5% of full deviation from best straight line through zero.
DC Drift .... ±0.5% of full deviation over 8 hr and 20°F (11°C) after 10 min warmup.
Input Level .... 0.5 to 10V pk
Input Impedance .... 20 kΩ or 75Ω, selectable by pin jumper
Harmonic Distortion .... 1.2% max for IB and WB Gp I modes, 3.0% max for WB Gp II.

HONEYWELL 101

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...continued

...Optional)

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...ocity and displace-
...amps may be

...MS, peak, absolute
...l or RMS of digi-
...l of digitally-filtered
...either proportional

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...iller or 1,026 dB/
...iter

- **Control accuracy:** For single channel control of a linear system through a resonance at 100 Hz at a sweep rate of 1 oct/min, the [illegible] less than ±1 dB with a Q = 30 and less than ±2 dB with a Q = 50. Accuracy is dependent on frequency, number of input channels, sweep rate, [illegible] range, linearity and transfer characteristics of the external load.

Shock (Optional)

- **Frequency ranges:** maximum shock response spectrum (SRS) analysis frequency is selectable from 10 Hz to 20,000 Hz. SRS ranges for control include 125 Hz, 312.5 Hz, 625 Hz, 1,250 Hz, 1,875 Hz, 2,500 Hz and 5,000 Hz.
- **Tolerance bands:** shock response spectrum and classical pulse
- **Pulse generator:** [illegible] trapezoidal generation of acceleration [illegible] versus time), shock synthesis (summed damped sinusoidal components), analog capture of time domain signals.
- **SRS definition:** absolute acceleration or relative displacement model of single degree of freedom system
- **SRS filter spacing:** 1/1 to 1/24 octave
- **Truncation:** user can define a portion of a wave-form as a primary response
- **Buffer duration:** 6.25 ms to 50 sec, selectable, depending upon frequency range and [illegible]
- **Automatic level schedule:** up to 16 levels can be preselected.
- **Output level:** 0 to −30dB selectable in [illegible] dB steps.
- **Input trigger:** adjustable level and delay from input signal, external analog or digital trigger
- **Algorithm accuracy:** less than ±[illegible] dB error in single degree of freedom simulation [illegible] peak detection algorithms.
- **System protection:** drive signal compared to specified maximum, reference wave-form checked for exceeding a preset acceleration, velocity, displacement or the maximum input voltage.

Other Available Software

- INTEN (acoustic analysis)
- MODAL (structural analysis)
- SDRC (advanced structural analysis packages)
  MODAL PLUS
  SABBA
  OPTIMOD

Display

- **Screen size:** 12" diagonal
- **Type:** raster scan video (NTSC standard)
- **Speed of transmission:** 4,000 char/sec
- **Graphics:** high speed display, fully annotated and calibrated with selective erase.

Physical Characteristics Dimensions (WxDxH)

- **Input module:** 19.7 x 11.5 x 26 inches (50 x 29 x 66 cm).
- **Data storage module:** 5.9 x [illegible] x 8.3 inches (15 x 7 x 21 cm).
- **Operator's terminal:** 18 x 10 x 15 inches (42 x 26 x 39 cm).

Weight

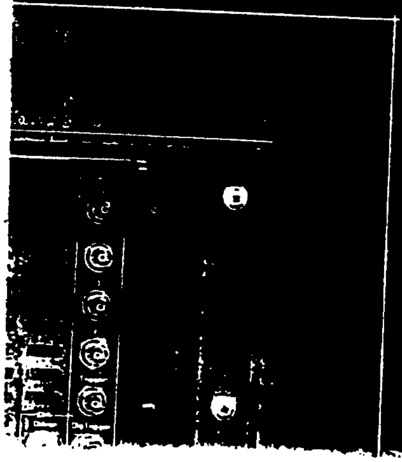
- **Input module:** 85 lbs nominal (38.5 kg).
- **Floppy disk module:** 3.2 lbs nominal (1.45 kg).
- **Winchester disk module:** 5 lbs nominal (2.25 kg)
- **Operator's terminal:** 33 lbs nominal (14.9 kg) including keyboard.

Power

- 115V or 230V, 50 or 60 Hz, 850 watts.

Environmental Operating Range

- **Temperature:** 40°F to 115°F (5° to 46°C)
- **Humidity:** 20% to 80% non-condensing.
- **Maximum thermal gradient:** 15°F per hour.



GEN RAD 2514

APPENDIX G

STINFO GUIDELINES

SCIENTIFIC AND TECHNICAL INFORMATION GROUP (STINFO) (AFWAL/IST)

1. TECHNICAL REPORT PROGRAM

STINFO is responsible for tracking all AFWAL technical reports from prior to the end of the effort to the printed copy of the technical report.

a. PREPARATION OF TECHNICAL REPORTS (TRs) - CONTRACTOR GENERATED

(1) The contractor prepares the draft technical report IAW-MIL-STD-847B and mails it to the engineer. Upon receipt of draft technical report, engineer attaches the draft technical report and a completed DD Form 1473 to an AFSC Form 2649 (AFSC Form 2649) (signed by group chief or higher echelon) and forwards the package to AFWAL/IST.

NOTE: If technical report is unclassified, unlimited, engineer will attach two copies of draft report and two copies of a "Request for Public Release Approval of Technical Information" from letter signed by division chief.

(2) STINFO will forward the draft technical report to the Technical Editing Group (AFWAL/FLISE) for assignment of a technical report number and editorial review. The edited draft technical report will be returned to the engineer with the following attachments:

a. Editorial comments
b. Transmittal letter/first endorsement
c. A NOTICE page (to be completed by engineer after he receives the camera-ready).

(3) Engineer will hod transmittal/first endorsement letter and mail the edited draft technical report and editorial comments to contractor. Contractor will prepare a camera-ready (original, typed) report incorporating editorial comments and forward it to engineer.

(4) Engineer will review camera-ready and then forward it to AFWAL/IST with the signed first endorsement, a signed NOTICE page and mailing list/mailing labels. (A double set of mailing labels, AF Forms 310, and a mailing list is required for a classified report. Engineer must also include a signed verification letter IAW AFWAL OI 205-1.)

b. PREPARATION OF TECHNICAL REPORTS (TRs) - IN-HOUSE

(1) Engineer will prepare an in-house technical report IAW-MIL-STD-847B, local editorial guidelines and ASD Sup 1 to AFSCR 80-20. Engineer will attach the technical report to AFSC Form 2649 (AFSC Form 2649), "Request for Editing of Draft Technical Report" (signed by group chief or higher echelon) and forward the package along with a diskette (if report was prepared on an IBM Word Processor or Xerox 860) to AFWAL/IST.

NOTE: If technical report is unclassified, unlimited, engineer will also

attach two copies of a "Request for Public Release Approval of Technical Information" form letter signed by division chief.

(2) STINFO will forward the technical report to the Technical Editing Group (AFWAL/GLISE) for assignment of a technical report number and editorial review. The report will be finalized in the Technical Publications and Display Group (AFWAL/GLISP). The finalized version will be forwarded to the engineer for review and sign off of notice page.

(3) The engineer will forward finalized version to AFWAL/IST with the signed first endorsement, signed NOTICE page, and mailing list/mailing labels. (A double set of mailing labels, AF Forms 310, (Secret reports only) and a mailing list, is required for a classified report. Engineer must also include a signed verification letter IAW AFWAL OI 205-1.)

c. MAILING LISTS

The following applies to mailing lists:

(1) A mailing list required for a classified report only. it must be accompanied by a letter of verification IAW AFWAL OI 205-1. The mailing list must also be incorporated as the last page(s) in the report and must be marked "UNCLASSIFIED" at the top and bottom with the appropriate page number.

(2) The following addresses are required for all mailing lists:

Defense Technical Information Center (DTIC)*
Cameron Station
Alexandria, VA 22304-6145

AUL/LSE
Maxwell AFB, AL 36112

AF/JACPD (T. Kundert) (Statement A reports only)
WPAFB, OH 45433-6523 In-House

AFWAL/IST (Library cy)
WPAFB, OH 45433-6523

AFWAL/IST (GIDEP cy) (Statement A reports only)
WPAFB, OH 45433-6523

SAF/AL (reports funded by In-House Independent Research
Wash DC 20330 Fund, PE 61101F only)

HQ USAF/RD (reports funded by Independent Research Funded,
Wash DC 20330 61101F only)

.pg

NSA (P2213)

Ft George G. Meed, MD 22705 (COMINT, ELINT AND COMSEC reports only)

* NOTE: A letter of justification is required if DTIC is omitted from a mailing list.

(3) The following addresses are required for individual laboratories:

(a) Avionics Laboratory

AFCSA/SAMI
Wash DC 20330-5425

AFEWC/ESRI
San Antonio, TX 78243 (AAW reports only)

(b) Aero Propulsion Laboratory

AFWAL/PS
WPAFB, OH 45433

(c) Flight Dynamics Laboratory

AFWAL/FIES (SURVIAC)
WPAFB OH, 45433

Battelle Columbus Labs
ATTN: TACTEC
505 King St
Columbus, OH 43201
(FIBA, FIBE, FIBR, FIBT & FIBC reports only)

AFWAL/FIBR (ASIAC)
WPAFB OH, 45433

(d) Materials Laboratory

AFWAL/MLB
WPAFB OH, 45433

AFWAL/MLL
WPAFB OH, 45433

AFWAL/MLT
WPAFB OH, 45433

AFWAL/MLP

WPAFB OH, 45433

d. MAILING LABELS

(1) The following guidelines apply to mailing labels for technical reports:

(a) A return address is required on each mailing label containing an off-base address.

(b) Mailing labels should be addressed as follows:

RADC/XP (Maj John Doe) Griffiss AFB NY 13441	(Preferred when address is government)

or

RADC/XP ATTN: Major John Doe Griffiss AFB NY 13441	(Acceptable)

or (Non-Government)

General Electric Co
ATTN: Mr John Doe
French Rd
Utica NY 13502

(2) An individual's name is never listed on the first or last line of an address.

(3) A double set of mailing labels for all off-base addressees is required for a classified report.

NOTE: The words "ATTN: Document Control" instead of an individual's name will be placed on one set of the mailing labels for a classified report.

Example:

Outer Label	Inner Label
General Electric Co ATTN: Document Control French Rd Utica NY 13502	General Electric Co ATTN: Mr John Doe French Rd Utica NY 13502

(4) The number of copies (if more than one copy) to be mailed to any particular address should be written in the lower right corner of the

mailing label. (Do not make the number of copies part of the mailing address.)

(5) All mailing labels containing foreign addresses must be reviewed/approved by ASD/COF. The mailing labels must be accompanied by a copy of the technical report.

2. TECHNICAL MEMORANDA (TMs)

a. Technical memoranda are authorized by AFSC for describing preliminary R&D efforts; i.e, studies, working papers, progress reports, notes, etc. Technical memoranda are primarily for use by AFWAL personnel to document in-house efforts. They are not to convey information significant enough to warrant preparation and distribution as a formal technical report.

b. Procedures for Preparation of Technical Memoranda

(1) The engineer prepares the technical memorandum.

(2) The engineer will obtain a technical memorandum number from STINFO. The technical memorandum number will appear in the upper right hand corner of the cover.

(3) The technical memorandum is prepared essentially in the same format used for technical reports; however, the NOTICE page and the DD Form 1473 are omitted. The technical memorandum is assembles as follows:

(a) Cover
(b) Foreword with review and approval statement signed by the approving official (Division or Branch Chief)
(c) Text
(d) References

(4) The technical memorandum cover will be uniform and unique in design. Covers will be made of bond paper with the AFWAL emblem and additional lines as indicated. The emblem is available from each division or STINFO.

(5) A distribution statement and export control law statement (if applicable) will be affixed to each unclassified technical memorandum.

(6) A technical memorandum does not require technical editing. Special illustrations may be secured on work orders to the Technical Publications and Display Group (AFWAL/GLISG).

(7) Local reproduction is authorized for the limited number of copies required, or the technical memorandum may be forwarded to 2750 ABW/DARR-2 for duplication. Include an AFLC Form 254 and a DD Form 843.

(8) Distribution of a technical memorandum should be limited (less than 40 copies), on a one-time basis, for informal use.

(9) The engineer will insure that AFWAL/IST receives a copy of each technical memorandum published.

3. BIENNIAL REVIEW

Each technical report containing a limited distribution statement is reviewed biennially by the engineer to determine if the limited distribution statement can be removed. STINFO notifies the engineer when the technical report must be reviewed by sending the engineer a biennial review form letter. The engineer checks the appropriate block in the first endorsement, signs the form letter and returns it to AFWAL/IST.

4. DTIC FORM 55, "REQUEST FOR LIMITED DOCUMENT"

Upon receipt of the DTIC Form 55 from DTIC, STINFO forwards the form to the appropriate engineer for approval/disapproval. Engineer returns approved/disapproved (white copy) of the form to AFWAL/IST. (Yellow copy of the DTIC Form 55 is retained by the engineer.) (NOTE: A yellow copy will not be available if the DTIC Form 55 was processed electronically.) The approved/disapproved DTIC Form 55 is forwarded to the Defense Technical Information Center (DTIC) for processing.

5. FL-88 (DTIC), "REQUEST FOR SCIENTIFIC AND TECHNICAL REPORTS"

FL-88 are requests from the Defense Technical Information Center (DTIC) for scientific and technical information. These requests are either answered directly by AFWAL/GLIST or forwarded to the appropriate engineer depending on the type of information requested.

6. REQUESTS FOR PUBLIC RELEASE APPROVAL

Engineer forwards two copies of a "Request for Public Release Approval" form letter signed by division chief or higher echelon with two (or seven) copies of material to be released to AFWAL/IST 15 working days prior to release data. AFWAL/IST forwards request to ASD/PA for approval. (Seven copies of material and 35 working days are required for requests requiring higher headquarters review.)

NOTE: No matter what size, shape, or form (reports, film, photo, speeches, etc) all technical information must be approved for public release prior to release. (Excludes information derived from 6.1 funding and 6.2 funding with universities on campus.) Also, all viewgraphs must be accompanied by text.

7. REQUEST FOR TECHNICAL INFORMATION FROM OTHER GOVERNMENT AGENCIES, INDUSTRY, OR INDIVIDUALS

Requests for technical information are either answered directly by AFWAL/IST or forwarded to the appropriate engineer depending on the type of information requested.

8. AIR FORCE INFORMATION FOR INDUSTRY OFFICE (AFIFIO)

a. The AFIFIO is one of three offices within the Air Force where contractors with appropriate clearances/need-to-know are allowed access to Air Force planning information. The other two offices are located in Pasadena, California and Alexandria, Virginia.

b. A Naval representative is also located in this office.

9. POTENTIAL CONTRACTOR PROGRAM (PCP)

The three AFIFIOs monitor the Air Force Potential Contractors Program. This program allows contractors who do not have active DOD contract access to planning information and R&D information in the Defense Technical Information Center (DTIC) data bank. Contractors must have demonstrable capabilities to perform R&D work to qualify for the PCP.

10. TECHNICAL MEETINGS

STINFO reviews all requests for sponsoring meetings, symposium, workshops, etc. The engineer prepares a request to sponsor or cosponsor a meeting, workshop, symposium, etc., six months prior to the event IAW AFR 80-43. The request is forwarded to the laboratory director for endorsement to AFWAL/CC. STINFO prepares AFWAL/CC's response. Higher headquarters (SAF/AA) approval is required for all limited/classified meetings. The request must contain the following:

a. Title of meeting
b. Date/location of meeting
c. Classification of meeting (If unclassified, state whether limited/unlimited.)
d. Inclusion/exclusion of foreign nationals. (Inclusion - a justification letter addressed to ASD/XOF must be prepared unless meeting is unclassified/unlimited. Exclusion - a justification letter addressed to ASD/COF and AF/CVAII IN TURN must be prepared.)
e. Facility security clearance
f. Cosponsor (if applicable)
g. Supporting organization (if applicable)
h. Estimated number of AFSc papers
i. Estimated total attendees
j. Estimated AFWAL costs
   (1) Travel
   (2) Per diem
   (3) Other
k. Total estimated number of manhours to be expanded by AFSC Personnel
   (1) Planning

(2) Secretarial support
(3) Miscellaneous

l. Name/telephone number of meeting manager
m. Name/telephone number of security manager (if meeting is classified)
n. Justification for sponsoring/co-sponsoring meeting

11. GOVERNMENT INDUSTRY DATA EXCHANGE PROGRAM (GIDEP)

STINFO is responsible for the AFWAL Government-Industry Data Exchange Program.

12. DEFENSE TECHNICAL INFORMATION CENTER (DTIC) ON-LINE RETRIEVAL SERVICE

STINFO is responsible for providing in-depth on-line search and retrieval service from the data base in DTIC. This service is performed primarily to avoid duplication of effort.

13. GUIDELINES

a. AFR 80-11, "Air Force Information for Industry Office"
b. AFSCR 80-20 and Sup 1, "AFSC Technical Report Program"
c. AFR 80-34, "Withholding of Unclassified Technical Data from Public Disclosure"
d. AFR 80-40, "The Scientific and Technical Information Program"
e. AFR 80-43, "Sponsoring or Co-sponsoring Unclassified and Classified Meetings"
f. AFR 80-44, "Defense Technical Information Center"
g. AFR 80-45 and AFSC Sup 1, "Distribution Statements on Technical Documents"
h. ASDR 190-1, "Clearance of Information for Release to the Public"
i. MIL-STD 847B, "Format Requirements for Scientific and Technical Reports"
j. AFSCR 800-20, "Defective Parts and Components Control Program (DPCCP)" (GIDEP)

PROCESSING OF TECHNICAL REPORTS

IST queries CAMIS for a list of TR due dates

IST notifies Branch of TR due dates

IST monitors time, if Draft TR becomes delinquent IST sends delinquent notice to engineer.

Engineer receives Draft TR from contractor, or completes Draft of In-House TR, and forwards to IST with a request for editing (AFSC Form 2649)

IST sends TR's to GLSE for editing

IST sends copy to ASD/PA* if applicable

GLISE assigns TR # and edits TR's

GLISE sends In-House TR's to GLISP

GLISP returns In-House TR's to GLISE

GLISE returns edited Draft TR's to engineer

Engineer approves/disapproves edited Draft/Final TR's for In-House TR's

Engineer returns edited Draft TR's to contractor for preparation of the Camera Ready Copy of TR's

*Camera ready sent to ASD/PA prior to ASD/DAR (if applicable)

PROCESSING OF TECHNICAL REPORTS

IST monitors time for return of camera-ready copy. If late, IST sends delinquent notice to engineer for contract TR's and to GLISE for In-House TR's

Engineering sends Camera-Ready copy of TR to IST

IST returns Camera-Ready to engineer for corrections

IST forwards Camera-Ready copy to ASD/DAR for printing*

IST forwards mailing labels and 310's if applicable, and DTIC Form 50** to the 2750th DAP

2750th returns one copy of printed TR to IST

2750th sends copy of non-exempt TR's to DTIC

IST sends one copy of printed TR to GLISL (Library)

**DTIC assigns AD# and returns Form 50 to AFWAL/IST

*Camera-Ready sent to ASD/PA prior to ASD/DAR (if applicable)

APPENDIX H

GLOSSARY OF TERMS AND LIST OF SYMBOLS

APPENDIX H

GLOSSARY OF TERMS AND LIST OF SYMBOLS

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H.1 GLOSSARY OF TERMS USED BY FIBG

Term	Meaning
Accuracy	Closeness of a measured value to the 'true value'.
ARRAY	FIBG's Vax 11/780 host name on Labsnet
Calibration	Defining the relationship between inputs and outputs of a measuring device.
Dynamic Range	Ratio of the largest to the smallest dynamic input that a instrument will faithfully measure.
Error	Difference between a measurement and the corresponding true value.
Modal Plus	Modal Analysis software package.
Noise	Undesired signal in a measurement.
Resolution	The smallest measurable input change.

H.2 LIST OF ABBREVIATIONS, SYMBOLS AND ACRONYMS USE BY FIBG

SYMBOL/ABBREVIATION	MEANING
AC	Alternating Current
A/D	Analog to Digital - Tape line
AFB	Air Force Base
AFFTC	Air Force Flight Test Center
AFWAL	Air Force Wright Aeronautical Laboratories
AGC	Automatic Gain Control
AGRA's	Automatic Gain Ranging Amplifiers
AM	Amplitude Modulation
ANG	Air National Guard
APD	Amplitude Probability Densities
ASD	Aeronautical Systems Division
BW	Bandwidth
BCD	Binary Coded Decimal
CDF	Cumulative Distribution Function
c.g.	Center of Gravity
CSD	Cross Spectral Density
D/A	Digital to Analog
DC	Direct Current
FDM	Frequency Division Multiplexing
FFT	Fast Fourier Transform
FM	Frequency Modulation
FRF	Frequency Response Function
FFT	Fast Fourier Transform
FT	Fourier Transform
g	Acceleration of 9.80 meters/second square
HAVE BOUNCE	Project under Rapid Runway Repair Program
ips	Inches Per Second
IRIG-B	Inter Range Instrumentation Group-B
ips	Inches Per Second
JPDF	Joint Probability Density Function
KIPS	Thousand Pounds
LTV	Ling Tempco Vought, Corporation
LVDT	Linear Variable Differential Transformer
MDAAV	Mobile Data Acquisition and Analysis Van
MHZ	Mega Hertz
PAM	Pulse Amplitude Modulation
PCM	Pulse Code Modulation
PDAP	Portable Data Acquisition Package
PDF	Probability Density Function
PM	Phase Modulation
PPM	Pulse Positive Modulation
PSD	Power Spectra Density
PSIA	Pounds Per Square Inch Absolute
PSIG	Pounds Per Square Inch Gauge
PTM	Pulse Time Modulation
PWM	Pulse Width Modulation
GR	Gain Resistor

GLOSSARY OF TERMS AND LIST OF SYMBOLS

RMS	Root Mean Square
RPM	Revolution Per Minute
SG	Strain Gage
SLOAD	Strut Load
SPL	Sound Pressure Level in Decibels
STINFO	Science and Technical Information
TDAS	Test Data Analysis System
TDM	Time Division Multiplexing
TDY	Temporary Duty
TF	Transfer Function
TM	Technical Memorandum
TM	Telemetry
TR	Technical Report
VDC	Volts Direct Current
Voût	Voltage Out
WPAFB	Wright-Patterson Air Force Base

FOREWORD

This report documents an in-house effort conducted by the Quality Circle of the Structural Dynamics Branch of the Structures Division, Flight Dynamics Laboratory, Air Force Wright Aeronautical Laboratories. This investigation was accomplished under ASDD0343, Quality Circles. The report was written during the period of August 1985 To December 1986.

The FIBG Quality Circle was formed in November 1983 with eleven members. The objective of the Quality Circles are directed at the following: (a) enhance productivity, (b) improve communications, (c) further employee morale, (d) improve working conditions, (e) promote teamwork, (f) reduce waste and (g) develop the creativity of the quality circle members. After brainstorming a number of possible concerns, on 9 January 1984 the choice for the Circles first problem was: "How can the Structural Dynamics Branch (FIBG) document their technical efforts in a timely manner?" As one solution to the above problem, the circle chose to publish this Report Writers Guide to assist FIBG personnel in publishing quality technical documents in a timely manner.

The members of the FIBG Quality Circle and authors of the Technical Memorandum wish to thank Mrs. A. Hatfield for helping prepare this manuscript.

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This Technical Memorandum has been reviewed and approved.

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